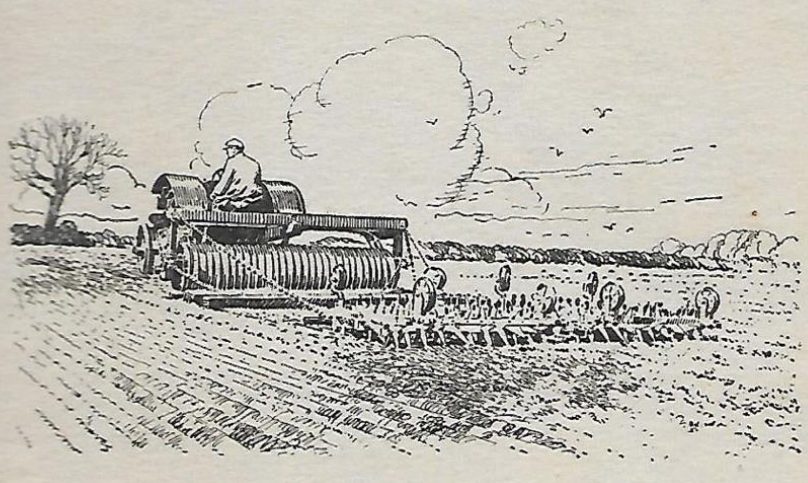
Mr. R. Seth
For information.

SUGAR BEET
ON THE CONTINENT



BULLETIN NUMBER 102

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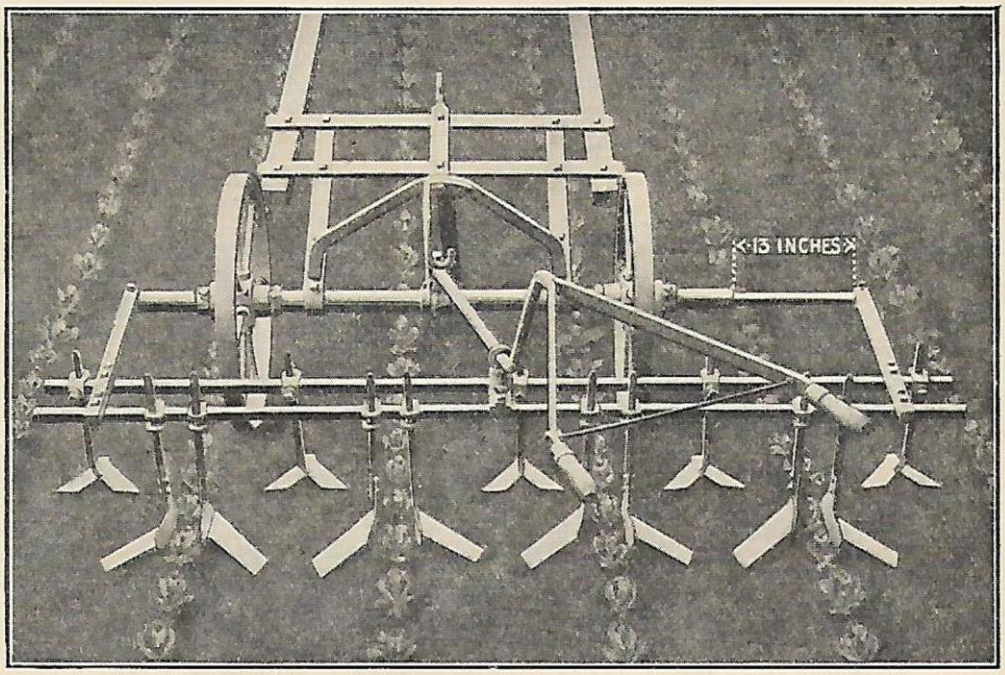

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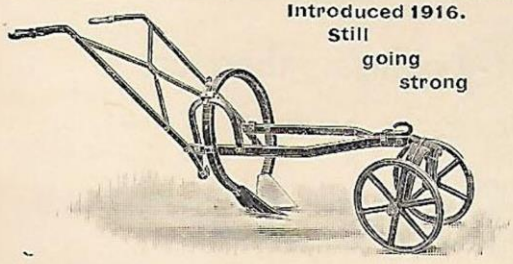

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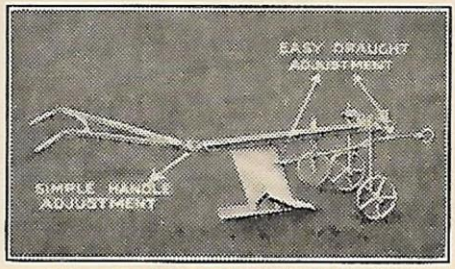

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MINISTRY OF AGRICULTURE AND FISHERIES

BULLETIN No. 102

THE CULTIVATION AND HARVESTING OF SUGAR-BEET ON THE CONTINENT

F. RAYNS, O.B.E., M.A.
(Norfolk Agricultural Station)
and
S. J. WRIGHT, M.A.
(Institute for Research in Agricultural Engineering, University of Oxford)

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FOREWORD

SUGAR-BEET has been cultivated on the Continent for so much longer than in this country that it was considered desirable to obtain first-hand knowledge of the methods adopted in the main beet-growing areas of Europe, and especially of any advances made during recent years in the use of mechanical appliances in the cultivation and harvesting of the crop. Mr. F. Rayns, O.B.E., M.A. (the Director of the Norfolk Agricultural Station) and Mr. S. J. Wright, M. A. (the Deputy Director of the Institute for Research in Agricultural Engineering) accordingly paid visits in the spring and autumn of 1935 to the European countries where the crop is chiefly grown. The costs of these journeys, which had the approval of the Ministry, were defrayed by the Sugar Beet Research and Education Committee.

The first part of the tour covered the period from April 28 to May 24, during which Belgium, Central Germany, Holland, Czechoslovakia, Hungary and German Silesia were visited, in that order, while the second part extended from September 30 to November 1, when the countries visited were Poland, U.S.S.R., Central Germany, South Sweden, Denmark, Holland, Belgium and Northern France. In addition, special visits were made to the Salon de la Machine Agricole in Paris in January and to the German National Agricultural Show in Hamburg in June. The authors gratefully acknowledge the generous assistance that was afforded to them by officials, specialists and growers wherever they travelled, and the Ministry desires to associate itself cordially with their expression of appreciation.

The investigators have now prepared a detailed report, and the Ministry has taken an early opportunity to make the information readily available by issuing the report as one of its series of Bulletins. It is hoped that the data included will assist in the development of mechanical aids to production.

10, Whitehall Place,
London, S.W. 1.

July, 1936.

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THE CULTIVATION AND HARVESTING OF SUGAR-BEET ON THE CONTINENT

INTRODUCTION

Itinerary.—In drawing up plans for the Continental tours on which this report is based, due regard was paid to the fact that our terms of reference expressly mentioned that we should include in our survey not only new machinery but all the ordinary implements of sugar-beet cultivation. In particular we considered that this made it desirable that the geographical scope of our tour should be as wide as circumstances would permit. For whereas the development of new machinery and the use of mechanical power may be due almost entirely to economic difficulties, the ordinary implements of cultivation in any country are the result of gradual evolution and are intimately bound up with local conditions of soil, climate and labour. Only, in fact, by contrasting one set of conditions with another over as wide a range as possible could our observations of the various methods employed be put in their proper perspective in relation to sugar-beet cultivation in this country.

Two separate tours were made, in the Spring and Autumn of 1935 respectively. In the first, which extended from April 28 to May 24, Belgium, Central Germany, Holland, Czechoslovakia, Hungary and German Silesia were visited in that order, while on the homeward journey return visits were made to Central Germany and Holland. The second tour extended from September 30 to November 1, and included Poland, U.S.S.R., South Sweden, Denmark and Northern France, as well as further visits to Central Germany, Holland and Belgium. In addition, special visits were made to the Salon de la Machine Agricole in Paris in January and to the German National Agricultural Show in Hamburg in June. In all, our journeys occupied 64 days, in which about 7,500 miles were travelled by rail between the principal points of the various districts, and some 2,000 miles more by relatively short car journeys in the districts themselves.

An obvious consequence of covering so much ground in a short time was that it was impossible to make anything like a complete study of sugar-beet cultivation in any one district. There was, on the other hand, the advantage that the more essential features of the various methods (since they recurred from district to district) were liable to force themselves on the attention to the almost automatic exclusion of such less important features as were dictated only by local custom.

While we made a number of visits to research institutes, trial fields and agricultural shows, most of our material was collected on commercial beet growing farms. We made a point of seeing sugar-beet in the field on every possible occasion, whether work was going on or not. In this way our questions about cultivations, manuring and so on were generally related to definite fields and so elicited concrete answers. During the autumn tour we made a number of counts of plant population.

In each district we were given facilities for inspecting the implements that were used, and in several instances complete collections ranging from the first cultivation to the lifting were specially staged for our benefit.

Throughout our journeys we were given every possible assistance by the various firms and individuals with whom we had established contact. Our thanks are especially due to the following: Mr. P. G. Kronacher, Mr. E. Gaspart, and to the Director and staff of the Sugar Beet Institute at Tirlemont for assistance in Belgium; to Messrs. J. P. and W. H. Dudok van Heel, and to the Director and staff of the Institute at Bergen-op-Zoom for assistance in Holland; to Dr. Rabbethge, Herr Buchting, Dr. Schneider and Herr Stumpke of the Zuckerfabrik Klein Wanzleben for assistance in Central Germany; to Mr. Sent Paul and Dr. Ranner for assistance in Silesia; to Dr. J. Hartmann, Dr. Hans von Kuffner and Dr. Schreiber for assistance in Czechoslovakia; to Mr. Harmat for assistance in Hungary; to Messrs. K. Buszczynski & Sons for assistance in Poland; to Mr. Skalyga for assistance in the U.S.S.R.; to Mr. C. F. Tranchell, Dr. J. Rasmusson, Mr. G. V. Cedorborg, Mr. H. Bynke and Mr. L. Houmann of the Svenska Sockerfabriks Aktiebolaget for assistance in Sweden; and to Mr. Viggo Lund of the Danske Sukerfabrikker for assistance in Denmark.

Notes on Climate, Soils and Labour Conditions.—In general the countries visited can be divided into two groups according to rainfall: the Central European or dry countries and the Atlantic or relatively wet countries. The former group includes Central Germany, Silesia, Czechoslovakia, Hungary, Poland and U.S.S.R. In these countries the annual rainfall does not exceed 21 inches and may be as low as 16 inches, while general climatic conditions differ appreciably from ours. Their atmosphere is less humid; they are hotter in summer and colder in winter; their growing period is shorter and their cereal harvest is earlier. Their beet factories' campaign closes earlier on account of early and severe autumn frosts. The Atlantic

countries include S. Sweden, Denmark, Holland, Belgium and N. France. Some parts of these countries are drier, and some wetter, than Great Britain—their rainfalls vary from 21 to 32 inches—but the general conditions in all of them resemble ours more closely.

In both groups of countries sugar-beet is grown almost exclusively on soils either naturally rich or in extremely good heart, and only exceptionally is it cultivated on light sandy soils. Geologically the soils vary considerably, but, considered from an agricultural standpoint, many of them have similar characteristics. The wind-borne soils of Central Germany and part of Belgium, and the alluvial soils of Denmark, Sweden and part of Holland are typical examples: both are deep, free-working, almost stoneless loams, to be compared in England only with the silty alluvial soils which constitute the best of our arable land. Among the other types may be mentioned the sea clays of the Dutch polders—heavy to work but yielding wonderful crops—and the black soils of Czechoslovakia, Poland and Silesia. Considered as a whole, beet growing soils on the Continent are definitely easier to work, more suited to the crop, and less varied in character, than the beet soils of this country.

Differences of climate and soil will, of course, affect the general methods of cultivation practised in the various districts. Another factor, especially important in connexion with the beet crop, is the cost of labour. In this respect the various countries can, with some reason, be divided roughly into the same two groups as before. In the countries with higher rainfall the average wages of agricultural workers appear on the whole to be about equal to our own; while in the drier countries they are generally appreciably less. Sometimes, of course, lower wages are associated with payments in kind or with certain privileges of land tenure about which we had no time to collect details. Yet even in the countries with the higher wage rates, growers have certain advantages which make their average costs of production lower than those ruling in Great Britain. Among these may be mentioned the greater experience of the work people leading to a greater output in a given time; a longer working day; a greater average yield which reduces the overall cost per ton of beet; and the fact that special arrangements often exist to make child labour available during the singling and lifting seasons. In nearly every country great importance was attached to the first of these factors: it was pointed out that most of the workers had a "family" experience of sugar-beet work extending over three generations.

The old system of importing large numbers of seasonal workers from other countries (notably from Poland) has practically disappeared on account of post-War frontier restrictions. In some countries the disappearance of this system created, at one time, considerable difficulties in connexion with sugar-beet cultivation and led to a definite movement towards machinery development. This was particularly the case in Germany where the Government's encouragement of early marriage and large families added a further complication by withdrawing large numbers of young women from the available labour force. Nowadays these difficulties are being overcome by an increasing tendency towards what may be called the "family system of labour". Under this system a peasant family takes over a certain area of beet land immediately after drilling and performs by hand all the necessary work, up to and including harvest. After harvest the family receives either a certain proportion of the crop or a lump sum in payment based on the actual yield obtained. This system has evidently done much to bring back the young married women into the available labour force, for in districts where it is customary the whole family could often be seen in the field at singling time. The mother and father together with any children old enough would be actually at work, while the younger children played about on the headland, generally in charge of the grandmother or some other elderly relative.

Taking the Continent as a whole, labour is rather cheaper and more plentiful than in Great Britain and in consequence less attention has been paid to the use of mechanical power. In this respect the methods of many of our growers are well in advance of anything that we saw abroad. Outside U.S.S.R., for example, we did not hear of a single instance in which tractors were used on the beet crop for any of the work intermediate between earlier seed-bed preparation and the harvest. They were used in many places for ploughing, cultivating and lifting but tractor drills and tractor-hoe equipment were virtually unknown. Nevertheless, the methods and implements which we saw often included features which, being based on a longer experience of beet growing, may be of interest and value to British farmers.

The U.S.S.R. provided exceptions to all rules. Although, in that country, cost of labour has no real significance, strenuous attempts are being made to apply mechanical power to every farming operation. Many of the innovations were interesting, but we had little opportunity of forming an opinion as to their effectiveness.

In the following pages the various stages of sugar-beet cultivation on the Continent as a whole are described in general terms, while those special features which appeared likely to be useful in Great Britain are dealt with in greater detail.

CULTIVATION

Ploughing and Subsoiling.—Early stubble breaking was almost universally practised. In the driest districts it took the form of a quick shallow ploughing so that a green crop could be sown at once, for ploughing-in deeply in the late autumn. In the Atlantic countries stubbles were broken with a cultivator and harrowed on much the same principle as in the East of England (although the land was generally clean enough to make such complete cultivation appear unnecessary), and were ploughed before winter. Elsewhere the stubbles were ploughed deeply as soon as possible after harvest, with steam tackle or tractors on the large farms, and with horses or oxen on the smaller ones. When the beet was to be manured with dung, ploughing was necessarily delayed, but, even so, in Germany the steam ploughs were busy on the dunged stubbles in October.

Deep ploughing for sugar-beet (at 12-14 in. depth) was the general rule in the Central European countries, but there was no unanimity of opinion elsewhere. In Denmark and Sweden cultivation at a depth greater than 9 in. was objected to for a variety of reasons. It was said to be unnecessary, to entail a greater expenditure on manures, and to cause diminished yields of succeeding crops. A farmer was heard to say to his son: "Deep ploughing may be all right for you when you get the farm, but it would ruin me". In the other Atlantic countries, while cultivation at depths greater than 9 in. was common, it was perhaps more often done by medium depth ploughing and subsoiling than by deep ploughing. In Holland on a farm where beet generally followed wheat in the rotation it was (rather surprisingly) the custom to subsoil before the wheat break.

Depth of ploughing depends so much on local conditions that no general argument from Continental practice is permissible. It is fair, however, to emphasize that every Continental grower ploughs at least 9 in. deep for sugar-beet and that the majority of them plough or subsoil much deeper. It is also fair to say that almost the only criticism that could be made of Swedish and Danish beet growing was a tendency to fanginess at a depth corresponding almost exactly to the depth of ploughing, although at the same time it should be pointed out that with

the short roots typical of Scandinavian strains, this fanginess would be less important than usual. On the whole Continental methods of ploughing are, with one exception, no better than those in England and have not progressed so far in the application of mechanical power. The exception is the use, notable in Holland, Belgium and France, of the one-way plough. Its advantages in saving time in setting out and closing the furrows, and in leaving a level ploughed surface, are so obvious that they need no further emphasis. Excellent types of these ploughs are available in the countries nearest to Great Britain and their use might well be more generally imitated here. Perhaps the best lesson is to be found in the fact that early ploughing for beet is the general rule. Obviously in England the previous crop cannot be cleared as soon as in, say, Poland or Germany, nor is there the risk, which exists in the same countries, of the work being held up by early severe frosts, but the principle of early ploughing is sound and should be kept in mind. As a rule the plough was not used again after its deep work, but, according to Continental experience, early autumn ploughing requires to be followed by rather earlier spring cultivation.

Seed-bed Preparation.—The outstanding features of Continental seed-beds are their fineness and firmness, characteristics which are accepted as good practice by beet growers at home. The difference is that the Continental seed-beds seem to be just a little more fine and firm than those here and that to get this result rather more work is sometimes put into them. This does not necessarily mean that drilling has to be delayed, for it is customary, especially on the larger estates and farms, to try as far as possible to complete the preparation and drilling of each field in one day. This practice requires a very large force of horses and men and was more evident in those countries in which an ample supply of cheap labour is available. Nevertheless, the principle of quick preparation of a firm and very fine seed-bed is sound, and, by dividing the field where necessary, can be applied even where labour is limited.

Particularly with sugar-beet (a small seed in a very tough husk) the actual methods of preparation depend so much on water supply and soil type that it will be better to discuss the two groups of countries separately.

CENTRAL EUROPEAN COUNTRIES.—According to Continental ideas a rough surface in early spring means a serious loss of soil moisture. To avoid this loss, and to encourage the early

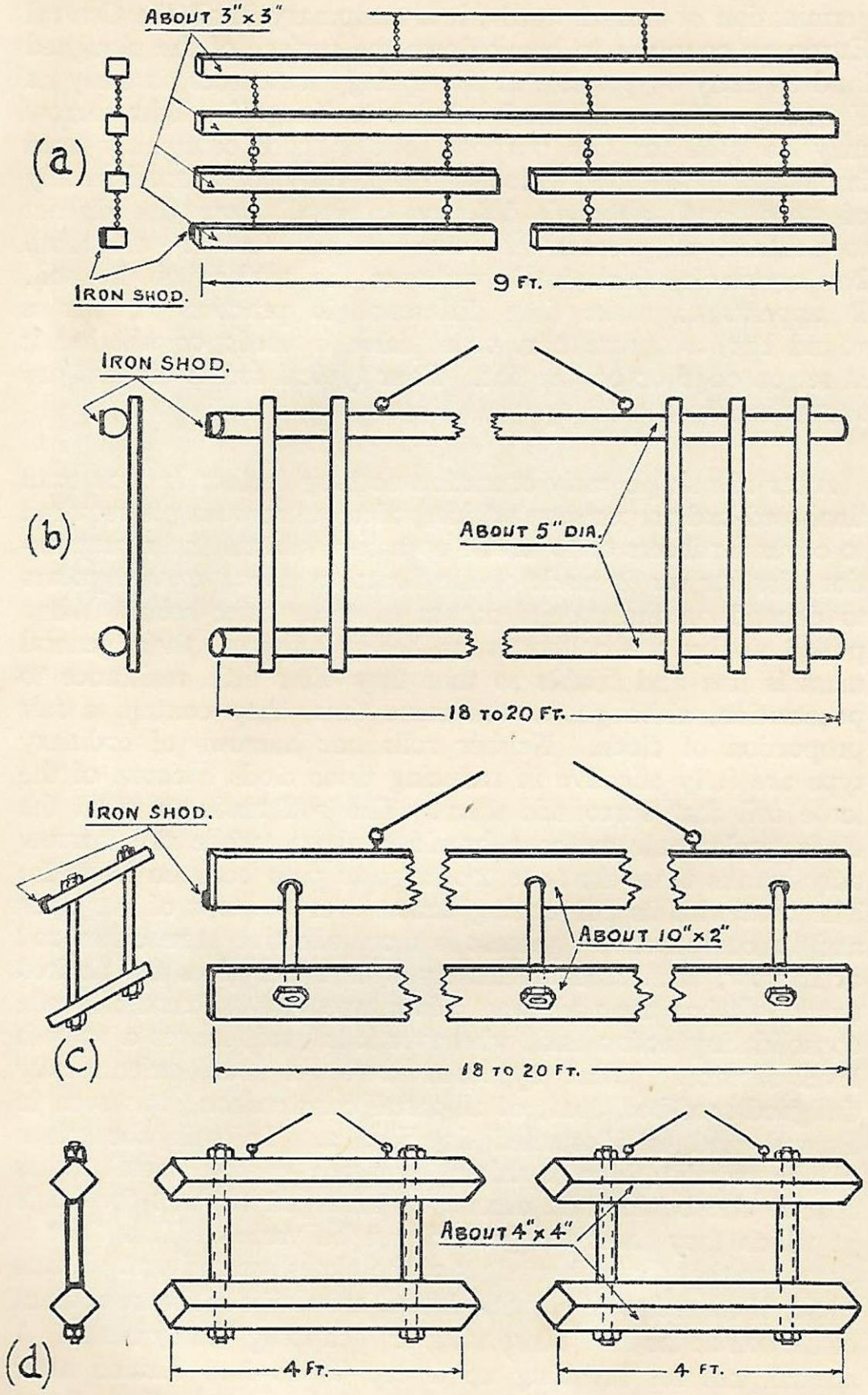
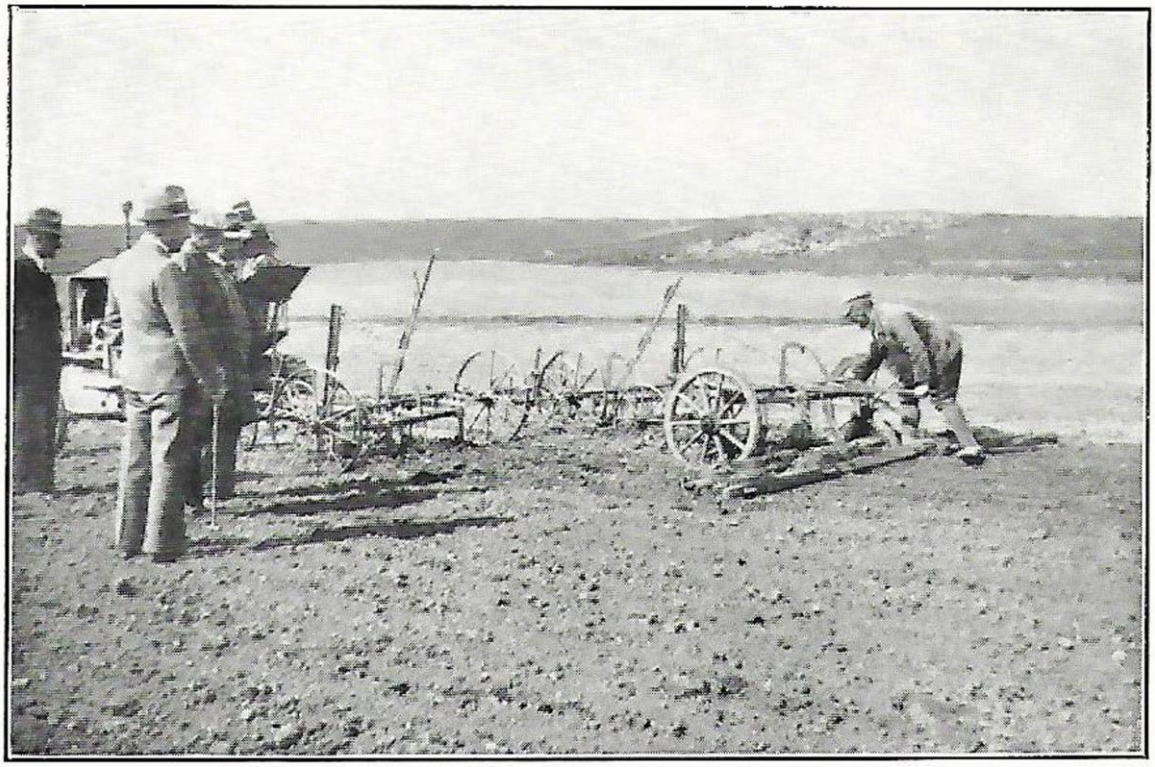


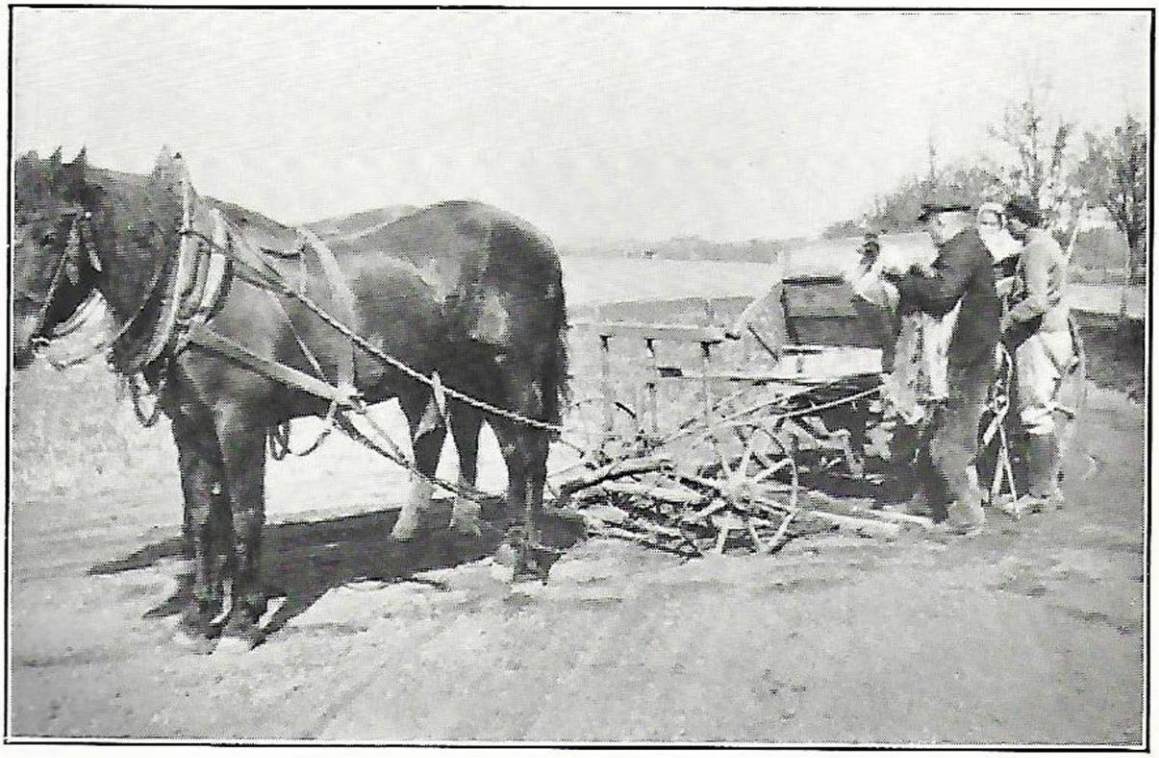
FIG. 1.—TYPES OF WOODEN FLOATS.
(*a*) Central Germany and Silesia, (*b*) Bohemia, (*c*) Slovakia, (*d*) Poland.

germination of annual weeds, it is customary in all the Central European countries to break down the surface of the ploughed land as early as possible in the spring, sometimes as early as February. Where the land is liable to " cap " a light harrow may be used for this purpose, but a more commonly used implement is the float. Floats are generally constructed mainly of wood, and, although differing in detail from one district to another, all possess the same essential feature—a smooth bar or plank which is drawn over the surface of the soil. It appears to make little difference in practice whether a round bar, a square bar, or a plank is used; or whether it is set on edge or on the flat. Four typical forms of float are shown in Fig. 1.

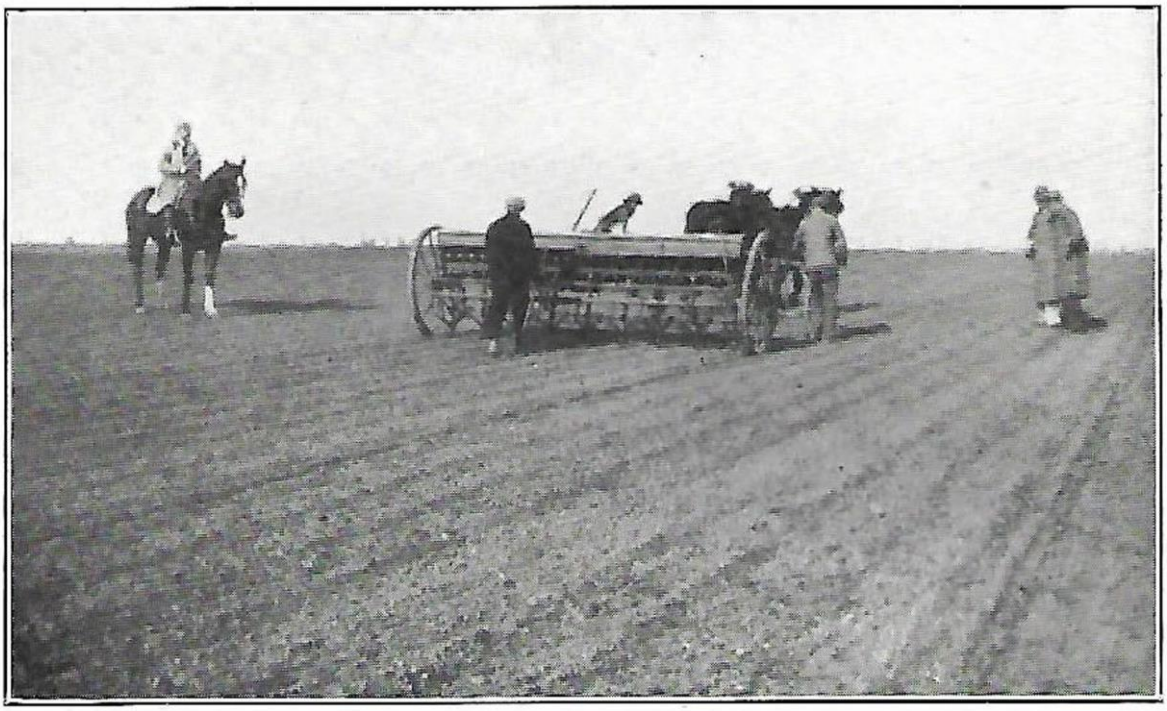
After this single early operation nothing further is done until final seed-bed preparation begins, unless a harrowing is required to cover fertilizers or to break up a cap. In the later preparations further use is made of the float: its effectiveness appears to depend on the special nature of these drier soils. When pulled up by the cultivator or heavy harrows, their general mass is fine and friable so that they offer little resistance to penetration, although, at the same time, they contain a fair proportion of clods. Neither rolls nor harrows of ordinary type are fully effective in reducing these clods because of the loose soil that surrounds them. The roll tends to push the clods underneath without breaking them, while the harrow only breaks those that are too large to pass between its teeth. The float with its pulverizing action over the tops of the clods and its comparative lightness is more effective than either roll or harrow, and, used alternately with them, gives the desired result. It has the additional advantage that it exerts a gentle consolidating action and, whenever it is used, leaves a smooth level surface. What appeared to be a more scientifically designed seed-bed float, of all-metal construction, was seen in Poland and is illustrated in Fig. 2. In this the place of the wooden bars is taken by three narrow metal plates spaced one behind the other and arranged so that the angle at which they meet the ground can be varied. This float is drawn so that the higher edges of the plates are in front. Floats must, of course, be used with due regard to the moisture content of the soil at the time of working or " capping " may result. A special tool for breaking up a cap which had formed after drilling was seen in Czechoslovakia. It was a light flat roll, on the surface of which were mounted a number of spiral rows of small pegs. The pegs were about $\frac{1}{4}$ in. in diameter and 2 in.



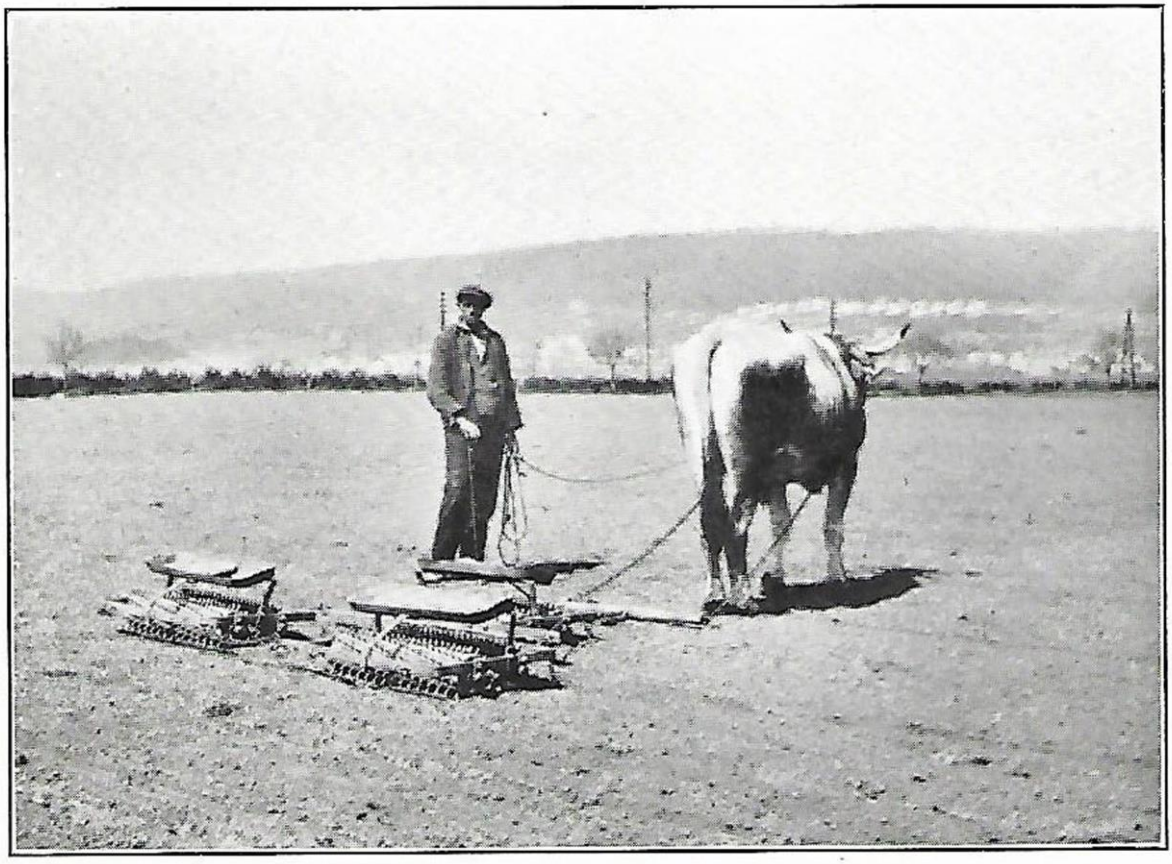
EARLY SEED-BED PREPARATION WITH LIGHT CULTIVATOR AND FLOAT. (Germany)



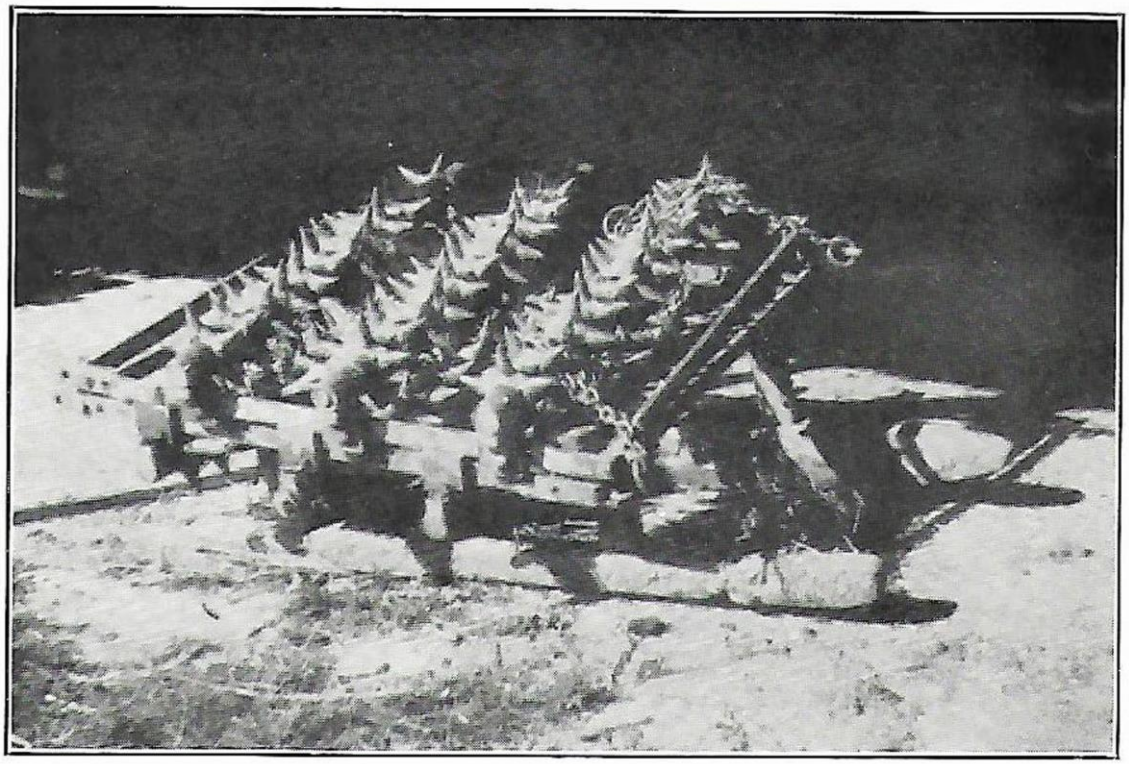
DRILLING ON A SMALL FARM IN GERMANY. Note the float used behind the forecarriage to take out hoofmarks.



A Nine-row Forecarriage Drill at Work. (Belgium)



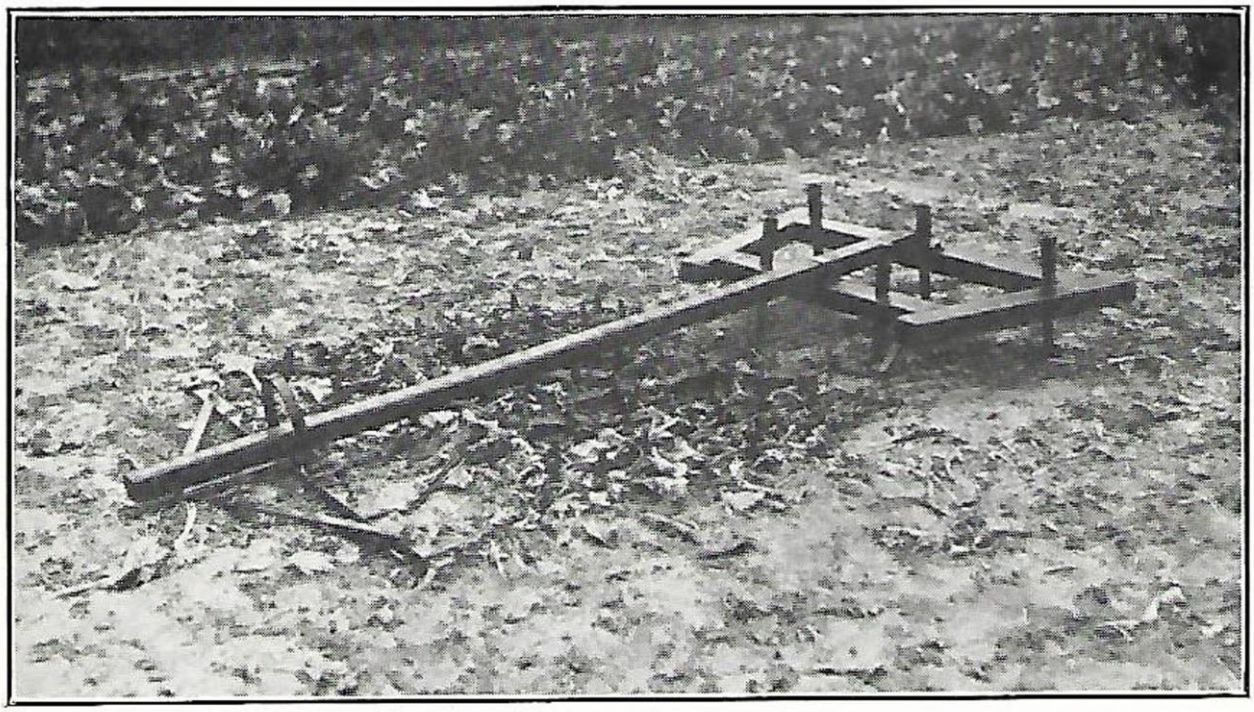
Light Crust-breaking Roller. (Czechoslovakia)



ROLLING HARROW. The two sections have been folded one on top of the other for transport. (Belgium)

ONE-MAN STEERAGE DRILL. (Belgium)

A Twelve-row Tractor Steering Hoe. (U.S.S.R.)



Combination of Tripod and Wooden Harrows as used for Cleaning Beet on the Ground. (Belgium)

long, and were numerous enough to support all the weight of the implement so that the flat roll did not touch the ground.

In these countries most of the harrows were of the ordinary zigzag type, the only feature worth noting being the wide range of sizes and weights that were available. Three different grades of harrows were often seen in use at the same time. The rolls, too, were of ordinary type but appeared to aim at rather greater consolidation by being generally smaller in diameter than our own. What were called " Cambridge Rolls " were widely used but differed from those in common use in this country in having flanged rings and notched rings

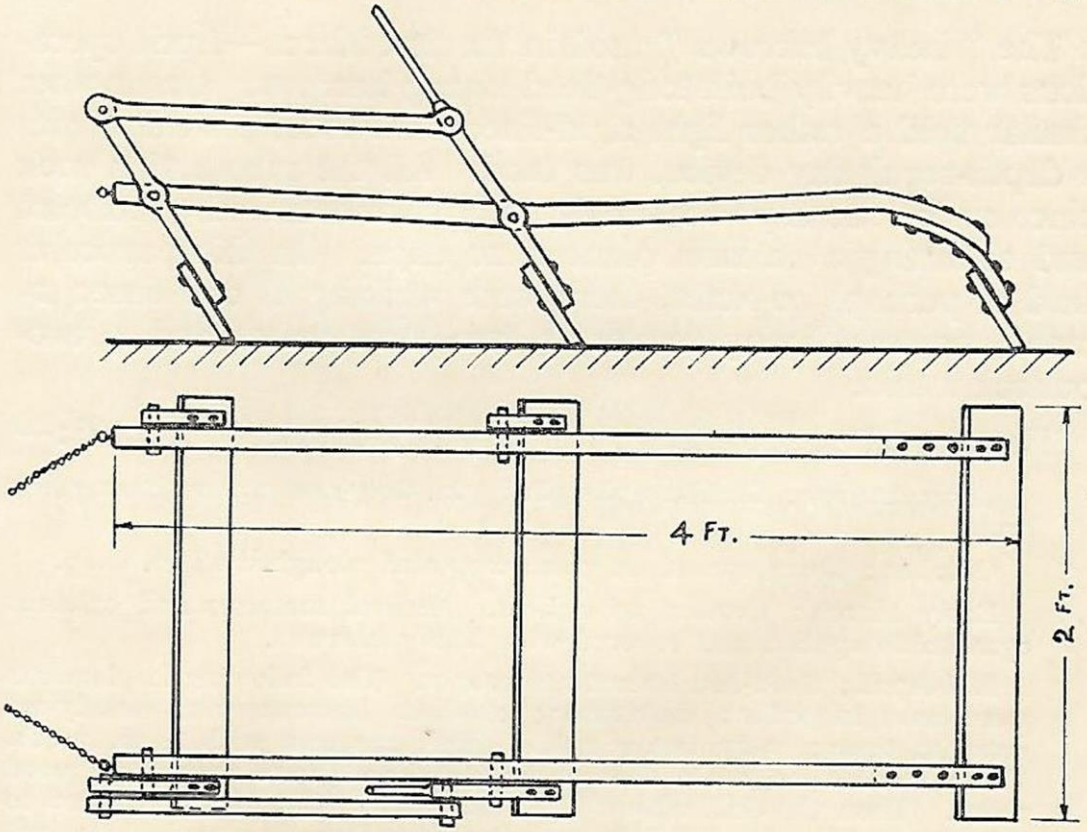


Fig. 2.—All-metal Float (Poland).

alternately. The flanged rings were exactly like the rings of our Cambridge rolls but between each pair of them was a stout flat disc with a notched circumference. The notches were about 3 in. deep and 3 in. wide at the base. The tops projected an inch or so beyond the flanges of the rings.

The sequence of operations with these implements will obviously depend on the conditions obtaining at the time of working. Two typical examples, may, however, be given in detail as an illustration, and may contain lessons for British cultivators. They have been chosen from several others, not because they are better, but because there was more opportunity to study them.

On a deep free-working and almost stoneless loam in Central Germany, the following procedure was adopted as preparation for sugar-beet after winter barley:—

Late July: Stubbles dunged and ploughed 14–16 in. deep.

February: Crossed with float; phosphate and potassic manures applied.

March—April: Seed-bed operations proper. The following implements were used in order: Heavy harrows with float behind (twice over); medium harrows; Cambridge roll; light harrows. Then came the drill, provided with a float between forecarriage and coulters to take out hoof marks, and afterwards a light harrow to cover in the seed. Four days after drilling a light harrowing was given and 4 days after that the Cambridge roll was used.

The "heavy harrows" used in the first March—April operations were heavily built long-tined zigzag harrows. On another similar field a rather light rigid-tined cultivator, provided with a depth-regulating device, was used. All the preparation took place on the one day with the dual object of conserving moisture and obtaining a uniform plant in 10 days. On this particular field of perhaps 40 acres, there were working at one time: 13 men, one tracklaying tractor, 5 two-horse teams and 4 two-bullock teams.

The second example is from a very dry district in Poland:—

Early August: Stubbles ploughed 3 in. deep and sown with a green crop.

October: Dung spread on green crop and ploughed 14 in. deep.

Early March: Crossed with float. Mineral manures and calcium cyanamide applied and covered with heavy harrows.

Mid-April: Seed-bed operations proper. The following implements were used in order: cultivator; medium harrows with closely-set straight tines; very heavy rolls; light harrows with 3 in. teeth. These worked no more than 2 in. deep and were sometimes used twice. Then the drill with a light harrow in front of the coulters to take out hoofmarks and light covering tines directly attached behind. Four days after drilling the Cambridge roll was used.

The aim was stated to be "all the plants out of the ground together," for which a quick and thorough preparation was necessary.

On both of these farms the first object was to produce a fine surface which, it was argued, conserved moisture in the early part of the year. The ultimate object was a uniformly fine, firm seed-bed. Some irregularity was inevitable but at drilling time what clod there was was always on the surface; none was left below to break the continuity of the soil particles.

Possibly the methods used in these dry countries have less direct application to British conditions than have those of the

wetter districts. Being essentially concerned with moisture conservation, however, they may be useful on some of the lightest British soils, especially those situated in the drier parts of East Anglia.

ATLANTIC COUNTRIES.—The methods of cultivation in these countries differ in several respects from those already described and resemble more closely those used in Great Britain. A later corn harvest makes very early ploughing and green manuring impossible, while, since moisture conservation is less important, very early spring cultivations are not generally practised. On these relatively wet soils implements which smear or " slade " over the surface must be used with greater caution and floats are not common. In the early cultivations only one implement of the kind was seen, a " planer " used in Belgium to break down 2 or 3 in. of the crest of the ploughed land. This tool resembled the Polish all-metal float previously described and had the same adjustable flat plates, but was pulled in the opposite direction so that the lower edges of the plates were leading. A set covering 12 ft. required 4 horses and, used when conditions were suitable, was said by one grower of repute greatly to assist the application of fertilizers and to save 30 per cent. of the subsequent cultivations. In the later stages of seed-bed preparation, floats were used only in some parts of Holland and Denmark. The Dutch float was like a rather heavy sledge on 4 runners and was pulled aslant to the direction of motion. It was used on heavy land, only when the top soil was dry enough, to rub down the surface of the seed-bed before a final very light harrowing. When necessary the action of this implement was intensified by the teamsman who stood on it and swayed it from side to side. More generally, however, the seed-beds, which were just as level and fine as in the drier countries and perhaps even firmer, were prepared almost entirely with rolls and harrows, but these implements, particularly the harrows, were often of types uncommon in this country.

For the earlier and deeper work, wooden harrows with relatively few long blunt tines were often used. Having relatively few tines these harrows would be likely to penetrate easily, so that in use their rather massive frames would be more or less in contact with the ground. Their action would appear to be similar to the combined action of heavy harrows and float as used elsewhere. A heavy wooden harrow seen in Holland had slanting tines which projected (to different depths) on either side of the frame. It was pointed out that

4 different actions could be obtained according to which side of the tool was uppermost and in which direction it was hauled. This harrow was also said to be swayed during its work by the teamsman in the same way as the sledge-like float.

Three other interesting types of harrow may be mentioned. The first is a rotary type, seen at work in Belgium and in implement displays elsewhere, which is illustrated in Fig. 3. It consists of a number of blunt pointed stars not more than 5 or 6 in. across which are mounted on a shaft so as to be free to revolve independently of one another. Three such shafts, each with its full complement of stars, were mounted one behind the other in a light frame-work. The units were used in gangs making up a width of about 12 ft. and requiring

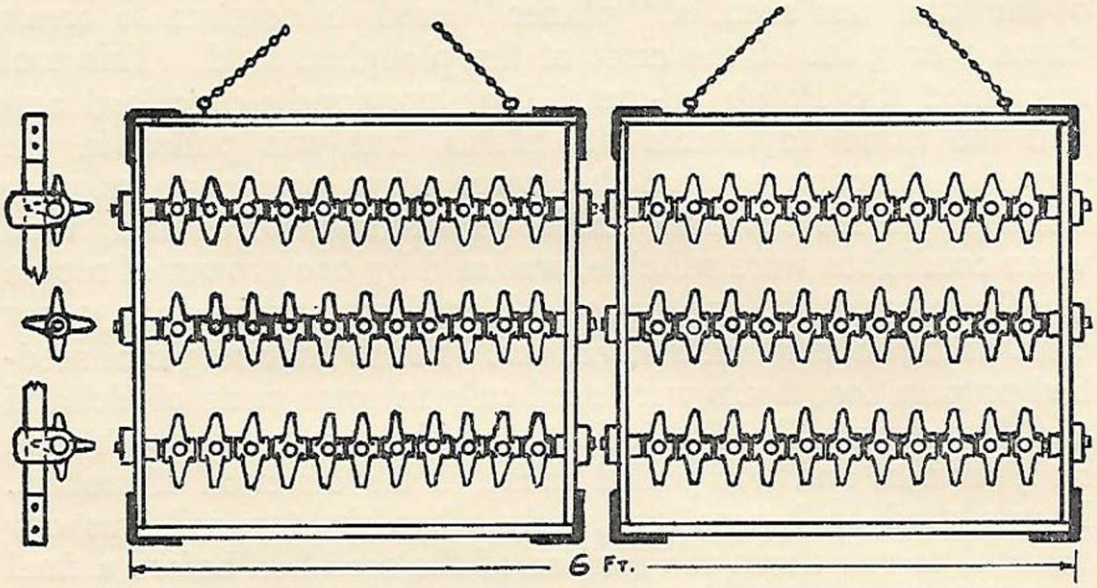


FIG. 3.—ROLLING HARROW (BELGIUM).

3 good horses. The literal translation of the name of this tool is the " Rolling Harrow "; a name which gives an apt description of its action. Another type was a rather heavy " tripod " chain harrow similar to those occasionally seen in this country. As will be seen later, this device was used for beet cleaning during harvest, but it was also extensively used on seed-beds. The essential feature of both these implements is that they are relatively heavy and have short blunt tines. Their action on the soil appeared to be a process of pulverizing from above as distinct from the stirring from below which generally characterizes a peg-type harrow. They were obviously intended to produce a well consolidated but finely worked surface: in fact, having regard to differences of soil and climate, they tended to reproduce the result given in the drier districts by the float. The third type was seen in Sweden. Externally

it was an ordinary light zigzag harrow, but its closely set tines had the angle shape shown in Fig. 13 (p. 35), again apparently with the object of producing surface consolidation without too much stirring.

Most of the rolls were of the type already described with alternate notched sections, while as an alternative there were also very small diameter ring rollers sometimes arranged in tandem in a frame. Two examples of the sequence of operations may be given.

In Belgium on a good medium loam almost free from stones :

November—January : Ploughed 9½ in. deep, subsoiled a further 3½ in.

Late March : Surface broken down with planer and fertilizers applied. Then came the cultivator, harrows, etc., in much the same way as in English practice, the only real difference being the use of the rolling and tripod harrows.

In Holland on a heavy sea clay, where no livestock was kept, the land was ploughed fairly deeply in autumn, having been subsoiled for the previous crop. In the spring the first implement used was the double-sided wooden harrow mentioned earlier. Then came a medium weight zigzag harrow and afterwards the sledge-like float. Finally a very light chain harrow was used or, if the land was very dry, a flat roll. After drilling a further rolling was given. In this case the various seed-bed operations were not generally carried out on the same day.

The second of these examples is specially interesting because of the use in a comparatively wet country of a float on a really heavy land.

Rather similar implements have been heard of as in use on some of our heavy Midland clays in the days before they were grassed down, and in turnip cultivation in the north.

Of Continental seed-beds as a whole it can be said that if they are on the whole better " finished " than those here, a good deal of the credit appears to be due to the greater range of implements that is available. We are, by comparison, lacking in implements intermediate in action between rolls and ordinary harrows. A definite impression was gained that Continental farmers place less reliance on rolls of ordinary type and rely more for consolidation on special types of harrows. The rolling harrow, in particular, appeared to be worth trying in England on account of the way in which it compresses the under soil while leaving the top inch fine and even, and the wider range of weather conditions in which it can be used. Of some of the other implements it might be said that they seem to " persuade " the soil to break up instead of forcing it to break unwillingly, as sometimes seems to be done by the tearing action of unyielding straight-tined harrows. None of them, of course, can be used without judgment in the light of the

conditions ruling at the actual place and time; and there is just as much difference of opinion abroad as at home over such a matter as whether it is better to drill on a rolled or harrowed surface. The end of the seed preparing operation is, however, generally much the same everywhere on the Continent —a flat, even mould on which drilling can be done under the best conditions. There are no obvious furrows, the surface is level, and even the hoof-marks are taken out at the last moment. These are small matters, but the effects of attention to details are cumulative, and in the long run they exert a big influence on the success of the result.

Drills and Drilling.—In comparison with our own machines, the most notable facts about Continental drills were that they were generally much wider and were almost universally fitted with forecarriage steering. It was unusual to see drills taking less than 6 rows, and in many places the standard implements took 9 or 10 rows of 40 cm. (15·75 in.). Greater steadiness in work and, possibly, the fewer wheelings, appeared to be the main reasons for wide implements. Labour saving had evidently little to do with it, for the widest drills were found in the districts with cheapest labour while the few narrow implements seen were in Holland and Denmark where labour is relatively dear. In general these wide drills required 2 horses and 3 men. Sufficient turning room at the headland was provided by drilling 2 bouts right round the field at the start. The arrangement of the forecarriage steering, particularly on the newer machines, was sometimes an improvement on the rather primitive arrangement common in this country. In most British drills the forecarriage is attached to the pole through a single pivot (or several pivots in one vertical line) and is free to turn so that the drill as a whole will not tend to run straight except in so far as it is compelled to do so by the steersman. In these circumstances, it is difficult to decide how much of the steersman's effort is required for genuinely steering the drill, and how much is used up in preventing or correcting the tendency of the forecarriage to wobble. In the Continental machines several different devices were used to correct this defect. The commonest and simplest is shown in Fig. 4. One end of the bar **A** is attached to a hook on the drill proper while the other end carries a toothed rack which engages with a pinion attached to the handle **B**. This rod forms a rigid connexion between forecarriage and drill so that, so long as the handle **B** does not turn, the drill will continue to run straight (or on a definite curve) of its own accord. The

leverage of the handle and its pinion makes it easy both to avoid wobbling and to exercise definite steering control. In another arrangement, the forecarriage was attached rigidly to the drill pole and was provided with Ackermann steering (like that of a motor car). This could be controlled either from a handle on the forecarriage by a man walking alongside, or from a steering wheel placed in front of a seat on the drill. To judge by the implements seen at the various works and shows, every manufacturer is making forecarriage drills which can be steered from the rear by a long tiller and so can be used as one-man drills. These were generally relatively narrow drills intended for small scale cultivators but some wide drills of the kind were seen. In these implements the steering refinements mentioned above were rendered unnecessary by the

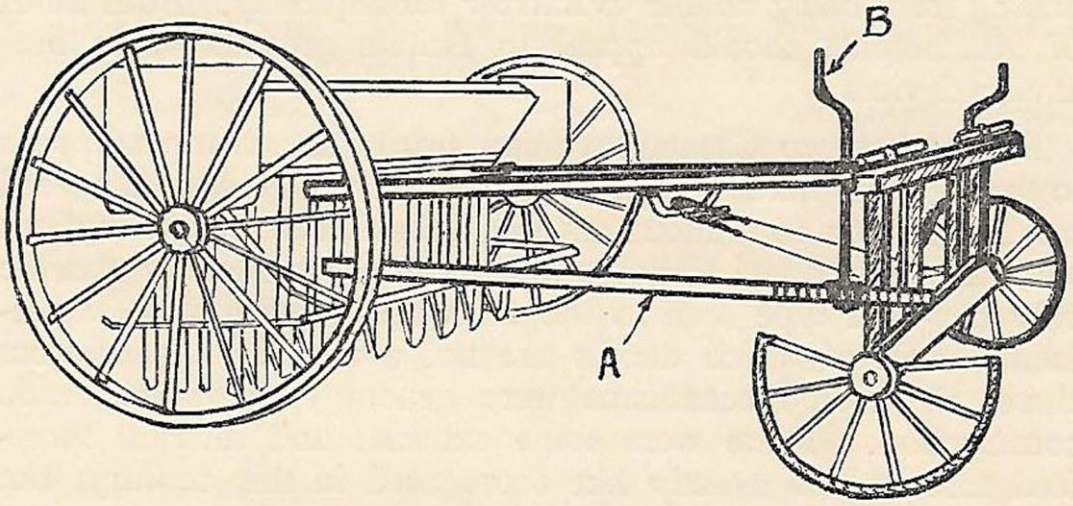


FIG. 4.—DRILL WITH "RACK AND PINION" FORECARRIAGE STEERING.

greater leverage of the rear-operated tiller, although rear control Ackermann steering was often used in the wider ones.

Either a small float or a light seed harrow was often placed between the forecarriage and the drill to take out hoof marks in front of the coulters. A harrow appeared to be more effective than a float for the purpose.

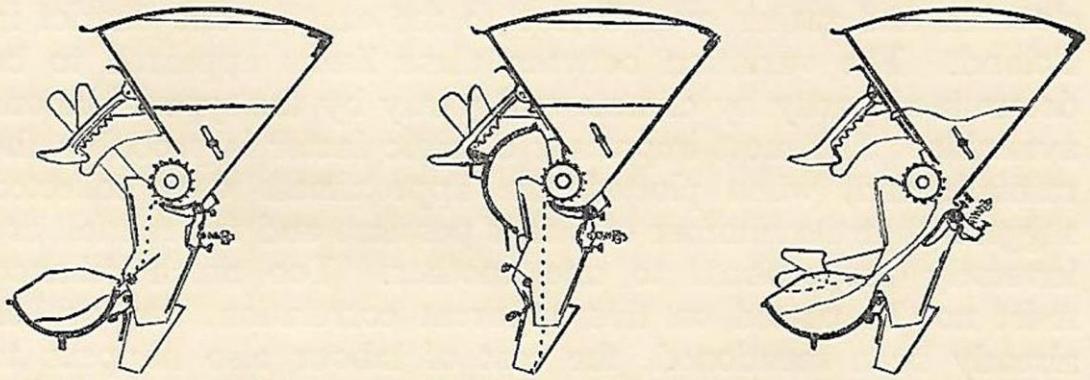
All sugar-beet drills were fitted with narrow Suffolk-type coulters which, on the customary fine, firm seed-bed, deposited the seed in sharply defined wedge-shaped furrows. Various attachments were used on occasion behind the coulters: small flat rollers about 5 in. in diameter and $2\frac{1}{2}$ in. wide: rather larger diameter narrower round-edged rollers; or any one of a number of different covering-in devices. No very definite opinions could be gained as to when any particular one of

these attachments was necessary or effective, and even on the same estate practice in regard to them was apt to vary. The small rollers may have various advantages in different circumstances: they may save a man and horse for rolling separately and at the same time give more effective consolidation where it is most needed; they indicate where the lines of plants will come and so permit inter-row cultivation before germination; while the imprint of the convex rolls may assist the early plant in a dry season either by sheltering it from wind or by leading the rain towards the seed. On the other hand, the rollers must be carefully set so as not to interfere with the depth of seeding; they must not be allowed to crack the surface; and they will increase the draught of the drill. Covering-in devices, too, may have the advantage in catchy weather of ensuring that the seed is properly covered and of reducing the risk arising from being unable to harrow subsequently. Both kinds of attachments should appeal to British growers as labour-saving devices.

Except by two Czechoslovakian firms, no attempts appear to have been made to produce any specially accurate feed mechanism for continuous sowing drills. The two exceptions were the well-known Melichar drill (which, incidentally was the only cup-feed type seen in use anywhere) and a new experimental drill of which details are not available. Apart from these, the feed mechanisms were generally of rather crude construction. There were some external and internal force-feed mechanisms exactly like those used in this country, but in the majority of instances the feed mechanism was a very simple cogged-wheel device often with hard rubber teeth. Nor, in general, was any attempt being made to increase regularity of seeding by lowering the seed-box. The idea, in fact, seemed to be to get a seed mechanism free from all danger of blocking and to ensure a good plant by using very high seed rates (25-30 lb. per acre). One improvement, however, was the use of smooth-bore seed tubes either of rubber or of telescopic metal construction. An interesting development on the part of a number of different drill makers is the provision of special devices to facilitate calibration of the seed rate. Fig. 5 shows the arrangement adopted by Siedersleben. It will be seen that a cover, which in the working position protects the feed mechanism, can be lowered to act as a trough which collects the seed delivered when calibration is in progress. At the same time, a flap attached to this cover acts as a by-pass and delivers the seed into the trough instead of into the seed tubes. The concave below the feed rollers can also be lowered to allow

rapid emptying of the drill hopper. This was one of the neatest arrangements seen, but several others were equally effective in operation. In one the cover of the drill hopper could be slid into brackets below the feed mechanism to form a conveniently large trough for the same purpose.

While some of the points of detail mentioned in the foregoing paragraphs might well receive attention from British manufacturers, it is doubtful whether the ideal drill for English conditions is to be found among the Continental machines. In the first place the fields here, on the average, are much smaller than those in nearly all the countries visited, so that the headland loss arising from the use of wide drills would be proportionately much greater. Having regard to this loss, no advantage is seen in having a drill larger than can be pulled by one horse. At the same time, steadier work will result from loading this horse fully, provided the drill is not so wide that



Calibrating position. Drilling position. Emptying position.

FIG. 5.—CALIBRATION DEVICE ON "SIEDERSLEBEN" DRILL.

the rolling action of the horse causes unsteadiness. A six 18-in. row drill will be better from this standpoint than the more common four-row machines, while 8 rows may be required on light land.

Again, while some form of steerage must be regarded as essential, it is not considered that the forecarriage type is necessarily the best. Like the wide drill, it requires too much headland, and if, by using Ackermann steering, it is made quick turning, the drill is likely to be too expensive to buy. A more promising alternative is the old fashioned British root drill with steerage coulters—an easily controlled rear-operated steerage drill that can be used by one man if necessary. This drill does not appear to be made to-day (although examples are to be found in use in the Eastern Counties) but it might well be revived.

Actually although it is known that one-man drilling is practised in some parts of England, it is not considered that it should be encouraged, for, in practice, it is impossible for one man to give the necessary attention to coulters, wheel-marks and horses all at the same time. Two men will make a much better job of the work and the extra cost will be well justified by results.

Plant Spacing.—Most Continental beet growers appeared to aim at higher plant populations than are common in this country. There was, of course, wide variation from one country to another, but in any one district there was relatively little difference of opinion on the subject, and only one instance was met—and that on very heavy yielding land in Holland—where a theoretical stand of less than 30,000 plants to the acre was considered satisfactory. At the other end of the scale, plants were seen spaced to give 50,000 to the acre in Czechoslovakia and rather over 60,000 to the acre in one district in Poland. The variation between these limits appeared to be determined partly by climate and partly by the type of labour available. The most important climatic factor is probably the rainfall, and, when plotted, the approximate data collected suggests that the number of plants per acre and the rainfall are inversely proportional to one another. Too much reliance must not be placed on this apparent correlation, for, as has already been mentioned, the cost of labour also happens to follow rainfall fairly closely. It would, however, be a fair conclusion to say that in the countries where the rainfall is less and the growing season shorter, growers believe that higher plant populations (from 40,000 to 60,000 plants per acre) are necessary and that, because labour is both plentiful and cheap, they are able to act in accordance with their belief. More important from our point of view is the fact that even in the wetter countries, where labour is more costly, they rarely aim at less than 30,000 plants per acre, while stands of from 32,000 to 36,000 are the more usual practice.

These higher plant populations are reached by making both row widths and inter-plant spacings narrower than in this country. Over most of the Continent, growers would agree that the best stands are left when the singlers work in narrow rows and the tendency, in general, is to make the rows as narrow as is consistent with easy horse hoeing. In consequence, there is relatively little variation from place to place; in fact, a range of from a little under 16 in. to a little over 18 in.

(that is from 40 to 48 cm.) would cover practically all the fields that were seen. Actually, although the average figure would be a little higher, easily the most common Continental row width is 40 cm. (15·75 in.), a figure which fits the standard 4 and 3·60 metre drills conveniently and which represents about the narrowest row that can be worked without damage from the horses' feet. Slightly wider rows were found in Scandinavia; in Denmark just under 19 in. was the usual practice, while in Sweden the average width was sometimes increased because two wider rows were included in each drill width for the horses to walk in. Rows narrower than 40 cm. were seen only in exceptional circumstances. In one district in Holland, the advantages of narrow rows in helping to secure a good plant, were so far recognized that the row width was narrower than the inter-plant spacing. Here although the rows were rather under 14 in. wide, the plants had evidently not been unduly damaged by the horses, for several fields were seen yielding over 20 tons to the acre. Narrower rows were also used in the few instances in which bunching by cross-blocking was practised.

Inter-plant spacing varied with row width and population from about 6 in. in Poland and Czechoslovakia to about 10 in. in Scandinavia, and nearly 16 in. in the special Dutch instance quoted above.

Actual singling practice varied very widely: in fact, in the course of the tour almost every conceivable way of getting the final plant was either seen or heard of. The four systems actually seen in operation give an idea of the widely different methods that are used. In Slovakia singling was being done at the second-leaf stage without previous bunching by large gangs of workers, using very short-handled hoes, on their hands and knees. In one field something like 250 men and women were at this task, organized, men and women separately, in gangs of about 40, each working in line under the close supervision of an overseer. The average wage of these workers appeared to be about 2d. per hour.

In Central Germany the plants were first bunched and then, a few days later, singled by smaller gangs of women working, again under an overseer, in V—formation across the field. In this case bunching was done in an upright posture, with long handled hoes, while singling was effected by finger and thumb. In Silesia bunching and singling were being done at the same

time by women and children working on piece work in independent groups; fairly short-handled hoes, requiring a bent back, were used. Each woman was allotted a total of $2\frac{1}{2}$ hectares (about $6\frac{1}{2}$ acres) per season. At present rates of exchange the piece work rate for bunching and singling corresponds to about 13s. 6d. per acre. The second hand hoeing was paid for separately, the rate being adjusted according to the quality of the singling. Finally, on one farm in Holland, bunching and singling were performed separately with a long-handled hoe much as in some parts of Great Britain, and bunching had not started when the plants were between the 4- and 6-leaf stages.

The choice among these and other methods must obviously depend mainly on the type and abundance of labour available. The fact that bunching by hoe, followed by singling by finger and thumb, was, perhaps, the most common Continental procedure indicates that the labour problem at singling time is less serious than in England. In regard to the standard of work required there was hardly any difference of opinion. Practically everyone insisted that the best developed plant should be left and that the singled plants should be left upright after the work. In Slovakia they were so insistent on the latter point that the workers were made to press a little soil around each plant by hand. A contrary view was, however, taken in Denmark where they insist on the workers causing the singled plants to fall flat because they claim that better cleaning around the plant is then possible. The greater care of the plant in the drier districts is undoubtedly associated with climate: effects of drought must be avoided at all costs and the activities of a particular beetle (*Cleonus punctiventris*) must be checked. (This beetle was of a great importance in Hungary, Slovakia, Russia and some parts of Poland: in some places trenches, in which it could be trapped, were dug all around the fields.) Even if these special considerations do not apply, it is difficult to justify the Danish procedure, for it would appear to be an elementary principle of beet cultivation to insist on the minimum possible disturbance of the singled plants from which, after all, the crop will eventually be harvested.

An indication of the general quality of Continental singling is given in the following table, in which the theoretical plant populations, and an estimate of the actual populations, are tabulated for a number of different countries. Figures for two different fields are given in each instance and the results of some English counts are shown for comparison.

NUMBERS OF PLANTS

Country	*Theoretical*	*Actual*	*Percentag of plant*
Germany	38,400	36,960	96
	37,450	35,900	96
Czechoslovakia	49,200	46,460	95
Poland	61,700	53,100	86
	42,560	36,900	86
Sweden	34,960	31,770	91
	37,180	33,920	91
Belgium	34,490	30,280	88
	32,720	33,180	100
Denmark	32,200	28,720	92
	32,200	29,660	92
N. France	31,360	29,160	93
	32,860	31,610	96
England	36,200	26,260	72
	29,860	28,240	95
	31,830	27,650	87

The estimates of actual plant population for the Continental countries are based, in each case, on 8 or 10 counts of 10 yd. lengths of row selected at random and measured by pacing; they are therefore approximate only. Except in the case of Czechoslovakia, these counts were made at lifting time and so include all possible kinds of plant losses. How far they are representative of average Continental practice is rather difficult to decide for there is no doubt some tendency for visitors to be shown the best fields. However, a great many fields of beet were seen from the road and from the train quite apart from those actually entered, and on the whole the figures given are thought to be fairly typical. The English figures are based on counts made on the fields of 12 good growers in each of 3 factory districts situated in different parts of the country. The most interesting feature of this table is the rough measure of attainment in each country as shown by the figures for "Percentage of plant" in the last column. The figures for this country are distinctly lower on the average than those estimated abroad. The difference is more striking when regard is paid to the theoretical stands aimed at; for while the overall English average is about 85 per cent., only 72 per cent. was attained when the theoretical stand was 36,200. The overall average for Germany and Sweden—countries aiming at the same order of population—was 93.5 per cent. Nor do weather conditions vitiate the comparison, for the English figures are worse than those of Germany and Czechoslovakia where the season was very dry, and than those in Sweden where the rainfall was greater than normal.

The foregoing figures do not include any instances in which mechanical methods of spacing were adopted. Two such methods were seen in operation: cross-blocking in Belgium and Germany and spaced-drilling in Sweden. Cross-blocking is not common in either of the two countries mentioned and is used in isolated cases only when there might be a risk of a plant growing away before singling could be done. The features of the method as used abroad are the same as those with which one is familiar in this country. A good initial plant is essential to success and a high seed rate is necessary, as much as 50 lb. per acre being sown in Germany. The work of bunching is done with ordinary horse hoes fitted with side hoes and used across narrower rows than are ordinarily sown. More plants are lost but the final stands were quite good in both countries, and were estimated at 89 per cent. of the theoretical stand in Germany and 88 per cent. in Belgium. Since, however, they aimed at rather higher theoretical populations than usual when fields were to be cross-blocked, the final stands in both countries were about equal to those in neighbouring fields worked in the ordinary way.

Except in Sweden, all the growers interviewed were inclined to scoff at spaced-drilling. In other countries a number of devices for the purpose were seen, these generally taking the form of attachments for ordinary drills, but not a single instance was heard of in which they had been used with success. Nor did it appear that any further experiments are being carried out with them. It was a surprise, therefore, during the first day in Sweden, to be taken into a very good field of beet and informed, quite casually, that it had been spaced-drilled. Counts on this field showed a population (at harvest time) of nearly 34,000 plants per acre. The rows were just under 18 in. apart while the inter-plant spacing was just under 10 in. The counts showed that about 91 per cent. of a full plant had been attained. Later several more such fields were inspected and it was stated that about 7 per cent. of Swedish growers are using the method.

The reason why spaced-drilling is successful in Sweden, in spite of its apparent failure elsewhere, is probably to be found in the drill that is used. This was made by the Czechoslovakian firm of Melichar, already well known in this country as makers of continuous-sowing drills. Curiously enough, nothing was heard of this drill, nor indeed of spaced-drilling, in its country of origin. The machine was particularly interesting because it embodied many of the general principles which work in

England on the subject has shown to be desirable. These features may be summed up as follows:—

(i) The seed was deposited by a coulter, of ordinary external shape, in a furrow exactly like that made by a continuous sowing drill. Other less successful machines have dibbled the seed into separate holes.

(ii) The spacing mechanism, a narrow roller with a notched rim, was fitted inside the coulter, and, therefore, delivered the seed at a point very close to the ground.

(iii) The spacing mechanism for all coulters was driven from the main wheels of the drill. In some other machines both at home and abroad the mechanisms for each coulter have been separately driven by some kind of small auxiliary wheel. Experiments, not only with spacing mechanisms, have shown over and over again that small diameter wheels will not drive accurately on agricultural land.

(iv) There were separate feed and spacing mechanisms but the feed mechanism was so crude that it fed a continuous dribble of seed to the spacing mechanism. At least one British-made drill has failed in the past mainly because the feed mechanism itself "parcelled out" the seed. In these circumstances synchronization between what are virtually two separate spacing mechanisms is necessary—and is very difficult to carry out in practice.

Further spaced-drilling experiments in England might well begin with the acquisition of a drill of this make, for, as has been pointed out, it represents very closely what should be aimed at if setting out to construct a machine.

Perhaps the most interesting point about Swedish spaced-drilling was not the machine which the Swedes used, but the reasons why they were interested in the method. They did not claim to save labour in singling. Nor, apparently, was the main reason the saving of seed, although by using only about 9 lb. per acre they did, in fact, effect a considerable saving by comparison with their ordinary seed rates. Their chief argument in favour of spaced-drilling was that it gave a more uniformly spaced final plant. It is quite possible that much of the difference of opinion about beet spacing in England is due to a failure to disentangle the two factors, uniformity, and number of plants per acre. The Swedes, at any rate, appreciate that there can be no such thing as an optimum number of plants for a given area unless there is uniformity as well, and they are making definite efforts to secure it.

Continental plant spacing can be summed up by saying that, on the whole, it was more regular than ours, and more successful in obtaining in practice the theoretical layout aimed at. Success in obtaining a plant depends in the first place on good germination and freedom from insect pests; after that it is entirely a question of the numbers and skill of the available labour. There

is no reason to suppose that Continental growers secure better germination than ours or that their plants are less liable to insect attack. They do, however, use higher seed rates, which are helpful both in providing more plants in a given length of row and in overcoming to some extent any inaccuracy of the drill. The most important points are undoubtedly the greater abundance of labour, and particularly of skilled labour, available for work in Continental sugar-beet fields, and the closer supervision that is given to it. Most people abroad agreed that better results were obtained when the work was done independently, rather than by the large gangs characteristic of the cheap-labour countries, but they all made a point of the advantages gained from the greater experience of their workers.

Horse Hoeing.—Except in two instances, horse hoes were of the same width as the drills. The exceptions were in parts of Holland and Denmark, where, although 4- and sometimes 6-row drills were used, only two rows were hoed at once. Most of the horse-hoes had forecarriage steering and the remarks already made about drill steerage apply equally well to them. Some countries favoured oxen for hoeing work because they walk more slowly and steadily and are considered less likely to damage the plant. From what was seen of oxen at work it was not considered that they offered any great advantage. In most countries there was no attempt to save labour in horse hoeing and the standard team of workers was 3 men, one leading, one on the forecarriage and one controlling the hoes. In Silesia, a boy was sometimes even added to the team to keep the hoe blades clear. The work was very well done, but, particularly when regard was paid to the very easy conditions of work, not better than much which might be seen in this country. Conditions were generally easy because the fields were level and the soil friable. Also, possibly because so many crops in Continental rotations are regularly horse hoed, the plants were very clean from the start. As an extreme instance of this the case may be quoted of a 450-acre farm in Belgium where the 1935 cropping was:

120	acres wheat	25	acres clover
40	,, barley	35	,, sugar-beet
150	,, peas	75	,, flax

With the single exception of the 25 acres of clover all these crops were horse hoed.

The general construction of the Continental hoes was very good. Frames were light but rigid, the steering was easy to work and counter-balances were fitted to the wider models for easier lifting. Almost without exception the hoe stems were

carried on independently self-regulating brackets. The 4 principal systems used for this purpose are shown in Fig. 6. With the possible exception of the system shown in Fig. 6a, all these arrangements have been seen on occasion in this country. Fig. 6b shows one of two alternative arrangements adopted by

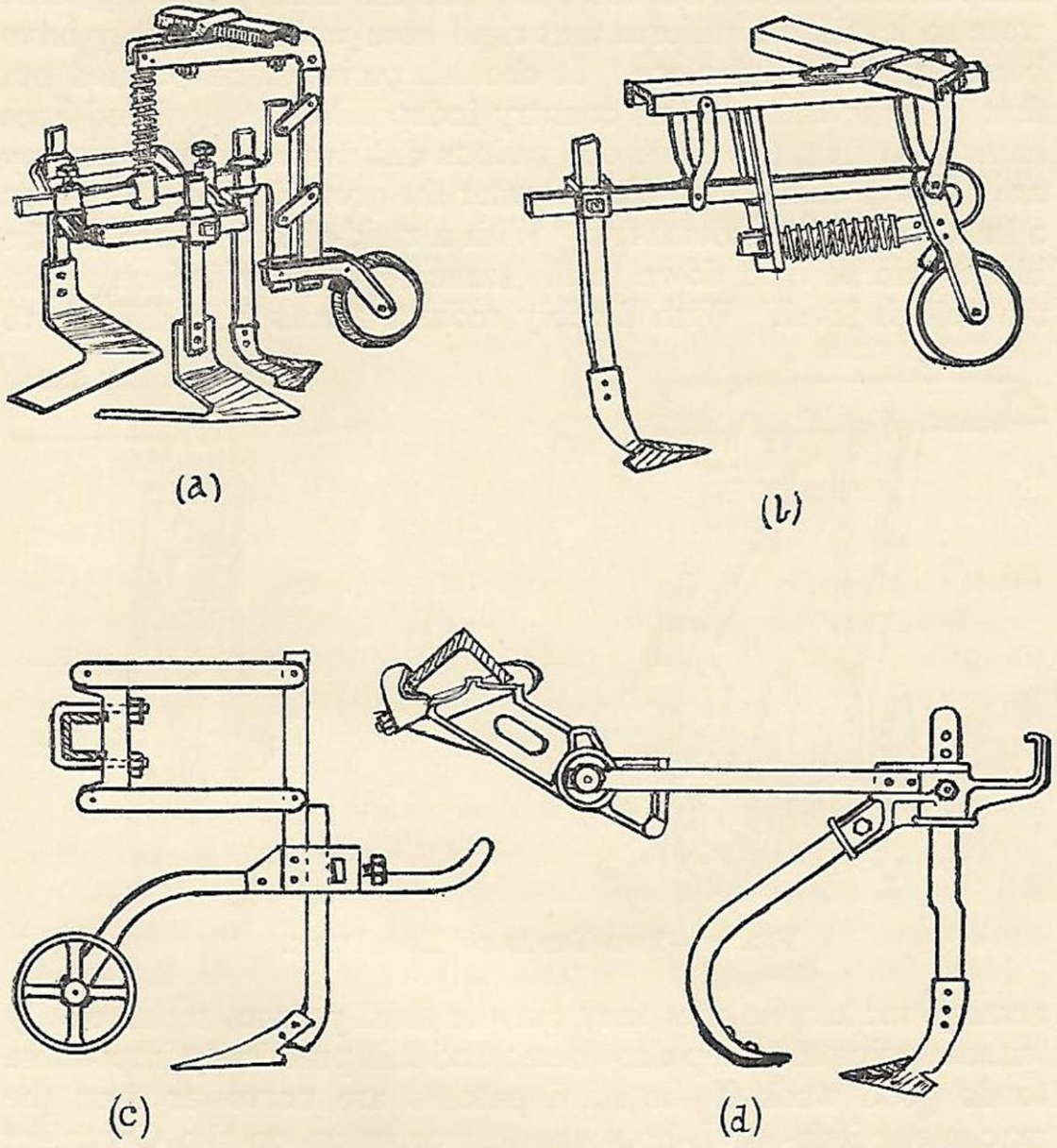


FIG. 6.—TYPES OF HOE MOUNTING.

the Czechoslovakian firm of Cervinka: a very similar arrangement has been adopted during the last two years by Messrs. Cornish & Lloyd of Bury St. Edmunds. Fig. 6c shows what is perhaps the most common Continental arrangement: imported machines of this type are occasionally seen in the Eastern counties where they appear to be known as "Dutch Hoes." Fig. 6d illustrates the Siedersleben system, which is almost universal in Germany and exactly similar to that used on the hoe acquired last year by the Norfolk Agricultural Station. It

was difficult to judge in the field whether any one of these arrangements was better than the others, for, as has already been mentioned, conditions were generally very favourable to good work. Indeed it was difficult to avoid the feeling that although every Continental country made a point of using these independently mounted hoes, most of the fields at hoeing time were so level and uniform that rigid hoes would probably have been equally satisfactory. It should, perhaps, be pointed out that in some cases in this country independently regulated hoes have been found to have one serious disadvantage in that they are liable to come out or fail to enter the ground altogether when a hard patch is encountered. With a rigid-stemmed hoe all the blades can be held down to the same depth provided only that the field is level. With flexibly mounted hoes it is difficult to

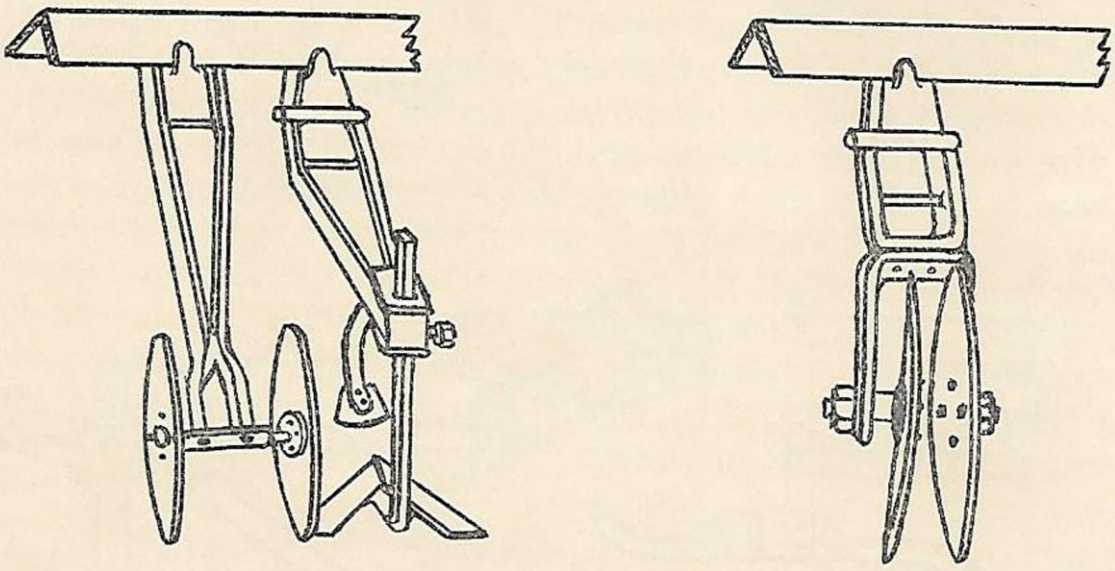


FIG. 7.—TWO TYPES OF HOE DISCS.

arrange matters so that they cut the hard patches satisfactorily without going too deep elsewhere; and it is practically impossible to do good work if the hard patches are narrower than the machine. Side- or L-hoes are less common on the Continent than A-hoes, although every manufacturer now supplies them if required. The use of discs in early hoeings is said to have originated with early attempts at cross-hoeing, but is now becoming common. Generally the discs are mounted in pairs independently of the hoe blades on a separate self-adjusting bracket. Fig. 7 shows two arrangements. In the arrangement shown on the left the discs are flat and are mounted parallel to one another on a common axle. This arrangement is efficient for second and third hoeings but for early work is less satisfactory than that shown on the right where the discs are slightly concave and can revolve and be adjusted independently. Discs

fitted to individual hoe-stems are also used occasionally. In a few instances the hoe blades between each pair of rows were followed by a very small Norwegian rotary harrow which improved the work by bringing partly buried weeds to the surface and breaking up any cap that had formed.

An interesting special purpose hoe was seen in Silesia. The hoe stems were hollow and rigidly mounted on a kind of water cart so that liquid farmyard manure could be applied during the last hoeing.

So far as the majority of British farms are concerned the writers consider that a forecarriage is an unnecessary complication, and one that requires more labour than is essential for good work. Nor is there much to be gained by having a machine wider than can be pulled by one horse, for two horses will be likely to do considerably more damage to the plant. Continental practice, however, suggests that it is possible, and desirable, to hoe at least 4 rows at a time. On the lighter lands one horse may be able to manage a 6-row hoe but the lift would need to be counterbalanced. Where the soil is uniform in texture independently regulated hoes are advantageous especially on irregular and sloping ground. Generally, however, rigid-stemmed hoes mounted on a sliding axle steerage are quite satisfactory. The sliding axle is probably a more important feature than the independently working hoes.

Tractor Hoe Equipment in the U.S.S.R.—Apart from such harvesting equipment as was in use during the visit, no sugar-beet machinery was seen. Fairly full information about the development of tractor hoes was obtained, however, both from discussions at the Sugar Research Institute and from photographs. All the tractors that were seen were of the (American) 4-wheeled general purpose type. These were in two sizes, and, although of Soviet manufacture, very closely resembled the four-wheeled International Farmall 20 and Farmall 30 respectively. These tractors had " dished " wheels which could be fitted either way round, but were not otherwise provided with facilities for adjustment to fit different row widths. Specially narrow wheels were used for sugar-beet cultivation, yet it was stated that it had been necessary, when introducing tractor implements, to increase the row width by about 2 in. to rather over 17 in. British growers have found, on the contrary, that when horses are replaced by tractors the row width can generally be reduced.

Since the Soviet tractors (and, it is understood, much of their other machinery) so closely resemble the foreign examples

imported in the early days of reconstruction, it was surprising to find that no use was made of standard American Row Crop tractor hoe attachments or similar devices. Like ourselves, the Russians evidently find it better not to use attachments fitted around the tractor but instead to rely on steerage implements drawn behind. Actually they have gone farther in this direction than we have, for whereas our steerage hoes are generally coupled directly and semi-rigidly to the rear of the tractor, the Russian hoes are self-contained and are simply hauled by the power unit. In developing their tractor hoes, the Russians appear to have started with ordinary 4- or 6-row horse-hoes drawn 2 or 3 at a time by the tractor. A suitable tractor hitch replaced the poles but otherwise the hoes were of the ordinary type and were steered by men walking behind. The next stage was to provide seats for the men; and the next, to make units sufficiently wide to load the tractor when used singly. The latest type of equipment is thus a 12-row hoe carried on two main wheels and a single rear castor wheel, and hitched to the smaller type of tractor through an ordinary draught pin. The hoes are independently mounted, on the Siedersleben principle, and the steerage is connected up to a steering wheel placed in front of a seat on which the steersman rides.

No direct information was secured as to the quality of the work done by these machines. Some plants were seen that appeared to have suffered considerable losses in cross-blocking, but it was not possible to find out what type of equipment had been used on them. The machines, however, are interesting as representing a development of the use of mechanical power, on parallel lines to, but going further than, our own. Technically (and judging only from photographs) the machines looked sound, and the development of similar outfits, as opposed to the rigidly attached types, may well be the next step in this country where conditions are suitable. An advantage of the system is that the tractor performs the function of a forecarriage so that only the detailed steering has to be done from the rear. (In a rigidly attached hoe, steering the tractor generally causes the hoes themselves to move in the wrong direction—a movement which has to be corrected or allowed for by the rear steersman.) The main disadvantage is that a wide headland is necessary.

Presumably the Russians are developing tractor drills of the same width as the hoes, but information on this point could not be obtained.

MANURING

Over most of the Continent stock feeding is closely associated with sugar-beet growing, and dung plays an important part in manuring the crop. The highest concentration of livestock on arable farms was found in Scandinavia where dairy farming and pig breeding went hand in hand with beet cultivation. Elsewhere dairy farming, yard-fed sheep or the fattening of cattle previously used as draught animals provide a fair quantity of animal manure, the majority of which is applied to the sugar-beet which takes up the greater part of the root break. On one Polish estate a large herd of low-grade dairy cows was kept virtually as a dung factory. They were fed exclusively on sugar-beet by-products and tail corn. No great attention was paid to their milk yield, and they were housed in large byres from which the dung was cleared only twice a year. On a Slovakian estate an unprofitable looking indigenous breed of pigs was kept for the same purpose. Even where other forms of livestock were not evident, large numbers of draught animals often supplied enough dung to form a basis for the manuring system. Great trouble is taken to make good farmyard manure and to avoid losses; heaps were built with architectural skill and were often continuously trampled by bullocks driven on top.

Arable sheep, as such, are unknown in most of the countries visited, mainly because in Central Europe the sharp winter makes winter housing essential. Sheep are kept in barns thickly spread with straw, the dung being carted on to the arable fields in due course. The sheep may walk over the beet fields in the day time but they do no more than clear up such leaves and tops as are missed when the tops are carted off for cattle feeding.

The quantity of dung used is obviously determined by the amount available. In Denmark and Sweden 15-20 tons per acre is a common dressing; in other countries anything from 20 down to 8 tons may be used: whatever the quantity it is invariably applied early and ploughed in deep. In a few instances no livestock was kept and beet was grown with artificials alone.

In the dry countries, and especially in Poland and Czechoslovakia, green manuring is quite general as a preparation for beet. The early harvest allows catch crops of rye, vetches, peas, crimson clover, beans, yellow lupins or seradella to be grown for ploughing in with the dung.

Artificial manures are universally used; in fact, in 12 countries not a single field of the beet seen was grown without

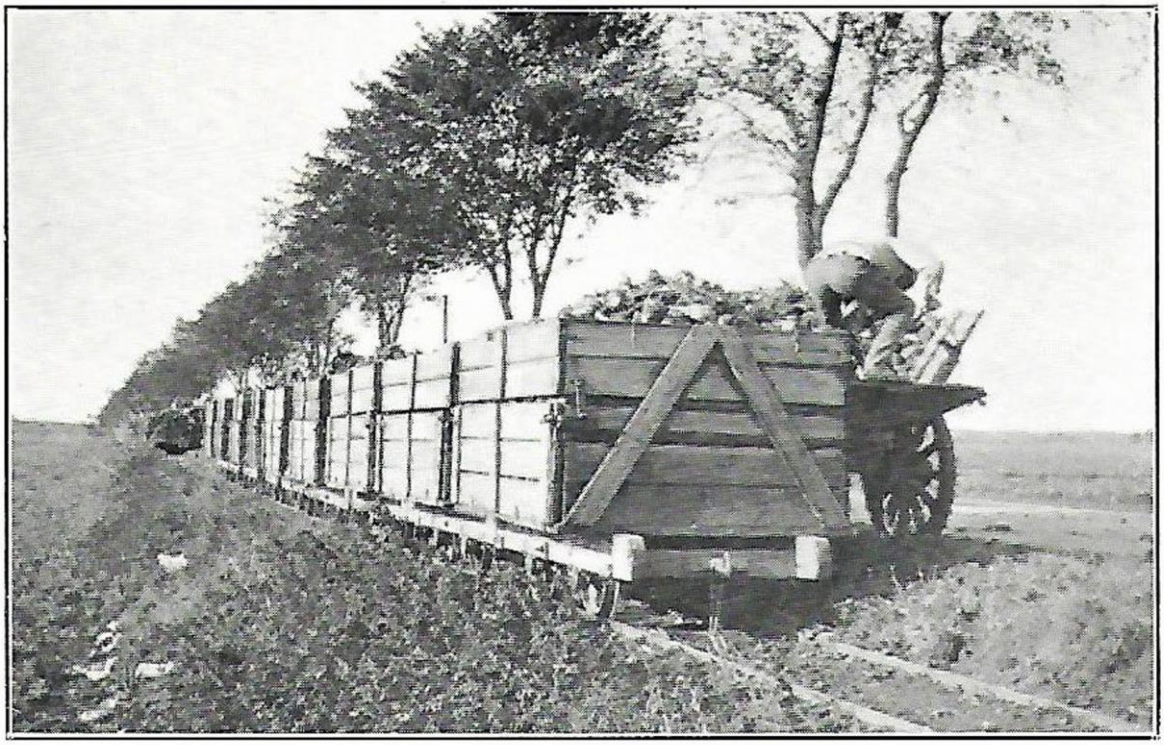
them. Various efforts are being made to predetermine the amounts to be applied. The methods used are, for the most part, well known to our agricultural chemists, and to attempt to discuss their merits would be outside the scope of this report. It may, however, be said that well organized attempts to determine the chemical requirements of beet soils were being made in Sweden, Germany, Czechoslovakia and Russia. No useful purpose would be served by giving details of the manuring practice in different countries. Kinds and grades of manure vary; soils and climates differ; while even political considerations may affect the choice of manures sufficiently to make a table of manurial prescriptions useless as a guide for British conditions. In the following general notes the various forms of manure have been resolved into their equivalent of sulphate of ammonia (20.5 per cent N), superphosphate (15 per cent. phosphoric acid), or muriate of potash (50 per cent. K_2O) as the case may be.

Lime.—The land is limed when necessary and sometimes even when no signs of soil acidity are evident. Lime sludge from the beet factories is a popular form.

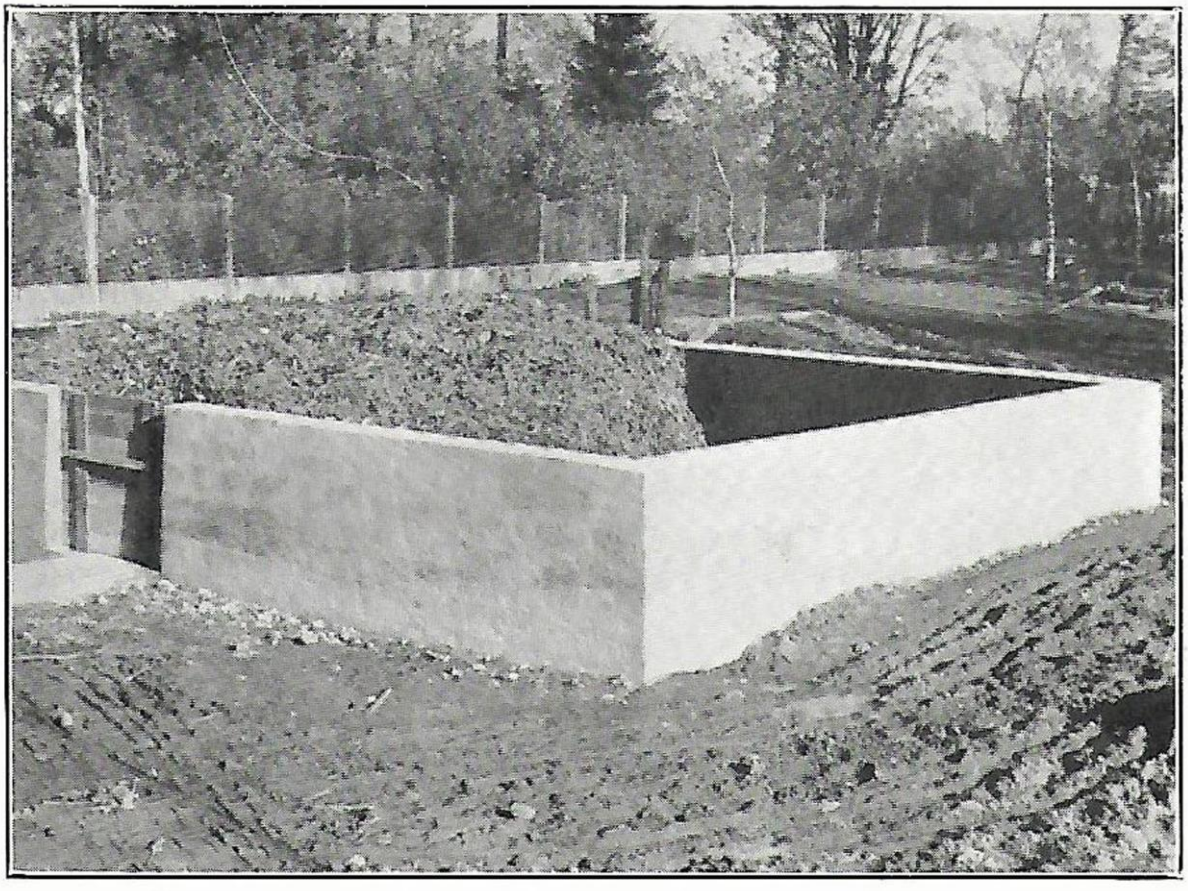
Nitrogenous Manure.—The general use of large quantities of nitrogenous manure is a feature of Continental practice. Up to 5 or 6 cwt. of sulphate of ammonia or its equivalent is not unusual where no dung is used; while with 20 tons of dung to the acre up to 3 cwt. is often applied. The wet countries use rather more nitrogenous manure than the dry; and Holland, France and Belgium rather more than Denmark and Sweden. In the dry countries 3 to 4 cwt. per acre is the maximum dressing according to whether dung is used or not. Top dressing with nitrogenous manures at two or three intervals is sometimes practised in the dry countries but, over the Continent as a whole, there is much evidence in favour of applying the whole amount before drilling.

Potash.—Potash manures were used in quantities equivalent to from 1 to 3 cwt. per acre of muriate of potash. Potash was not used on heavy land in Holland and was often omitted in Sweden, on the results of soil analyses.

Phosphates.—The quantities applied varied considerably. As much as 9 cwt. per acre of a manure containing 15 per cent. of phosphoric acid were used occasionally in Belgium and France, and as little as 2 cwt. per acre in Sweden and Denmark. Intermediate quantities were used in Germany, Poland and Holland.



LOADING BEET ON TO FIELD RAILWAY. (Germany)



CONCRETE PIT FOR TOP AND PULP SILAGE. (Sweden)

Artificials were only occasionally sown with combined seed and fertilizer drills, and it was emphasized that certain manures interfere with plant development when sown with the seed.

However much the foregoing observations may depend on local conditions they at least suggest three things: that beet requires heavy nitrogenous manuring; that the dung cart is still an important factor; and that more lavish manuring is practised on the Continent than at home. Even in Sweden, where endless trouble is taken to find out the chemical requirements of good soils, they dress heavily with dung: at the Alnarp Farm School they used 5-6 cwt. of artificials per acre with 25 tons of dung and 15-20 tons of liquid manure. In Denmark with heavy dressings of dung they use about 6½ cwt. of artificials per acre: 3 cwt. nitrogenous, 2 cwt. phosphatic and 1½ cwt. potassic. The nearer to Great Britain the more heavily is the beet manured, and, unless Continental farmers are spending a lot of money unnecessarily, their practice suggests that British growers are not farming highly enough for the beet crop. On the other hand, the manuring of sugar-beet in England is being investigated by the Rothamsted Experimental Station and it is likely that it will soon be possible to examine Continental manuring practice in the light of co-ordinated experimental work in this country. Until the results of this work are available some reserve is necessary in copying Continental procedure.

HARVESTING

Lifting and Topping.—The organization in the field of the Continental beet harvest does not differ essentially from our own practice. While there were many different lifters of the "loosener" type, some of which were worth noting, the use even of these is by no means universal, and a considerable proportion of the Continental crop is lifted by hand with ordinary short-handled spuds. The hand-spud is regarded as having certain advantages: the roots are easier to clean because less soil adheres to them, and there is less disturbance of the soil to hinder carting-off. Lifting with a spud is also probably the cheapest method when the cost of working a loosener is taken into account. Where looseners were used, pulling and knocking kept pace with them and no attempt was made to determine the state of dryness of the soil at which it could most easily be removed. As in England the work proceeded as quickly as possible, the only object being to harvest the beet at the earliest moment. Generally the heaps

of beet were 9 yds. apart in all directions, and were therefore rather larger than in England. This makes for quicker loading and carting-off but may slow up the actual lifting. Distance between heaps, however, is largely controlled by the available labour and when it is necessary to be quick as, for instance, on piece work, the distance is smaller. Except in one or two instances topping was done by hand either with a chopper as the beet lay in rows on the ground or, perhaps more often, with a hook, the worker standing upright and picking up the beet one by one with the point.

In Germany it was stated that 7 women would lift by hand, knock and top one acre in one day. They usually leave 21 heaps of beet per acre, but are paid less money if they leave more, and less also if they are working behind a lifter.

Topping by hoe before lifting was seen on a small scale in Sweden and Germany. In the former country the method was used only in connexion with a trial of the A.P.H. Salling combined lifter-cleaner-loader. (This is the "Danish" machine that was demonstrated at the Norfolk Agricultural Station last year, but which from later information appears to be of Swedish origin.) In Central Germany topping in the ground was being done by one or two small-scale farmers whose labour resources were limited and who placed special reliance on freshly harvested tops for stock feeding. Where the tops are to be cleared immediately, topping in the ground may save some labour and certainly makes the work easier for the labourers. The roots must, it was stated, be lifted within 24 hours or so, or losses in sugar will result. Only one machine for topping in the ground was seen. This was in use in Belgium and consisted of a triangular-shaped hoe cutter mounted on a steerage chassis and provided with the usual kind of device for automatically regulating the height of the cut. Its work did not appear to be as good as that of some of the machines that have already been tried in this country.

Topping standards varied considerably in different localities, the limits of current practice (excluding U.S.S.R.) being represented by S. Sweden where topping was very light and Central Germany where the reverse was the practice. In S. Sweden it is argued that, while beet by-products are highly valuable to the farmer, it is not good policy to try to obtain stock feed at the expense of sugar yield. According to current British ideas the Swedes go too far in this direction and their beet would almost certainly incur a heavy-top tare if sent to our factories. In Central Germany, on the other hand, there is a

tendency amongst growers of sugar-beet (which appears to be encouraged by the factories) to regard stock feeding as of equal importance with sugar production. Among the smaller growers particularly, beet were commonly topped a good inch below the lowest leaf scar and a considerable reduction of yield must often have resulted.

In U.S.S.R. topping is done so as to give the highest possible yield of roots regardless of every other consideration. Beet are topped so that they are left with a convex crown, and, in hand work, the top is practically " pared " off. This method of topping was said to increase the yield by 8 per cent. Several semi-mechanical devices have been introduced for topping on

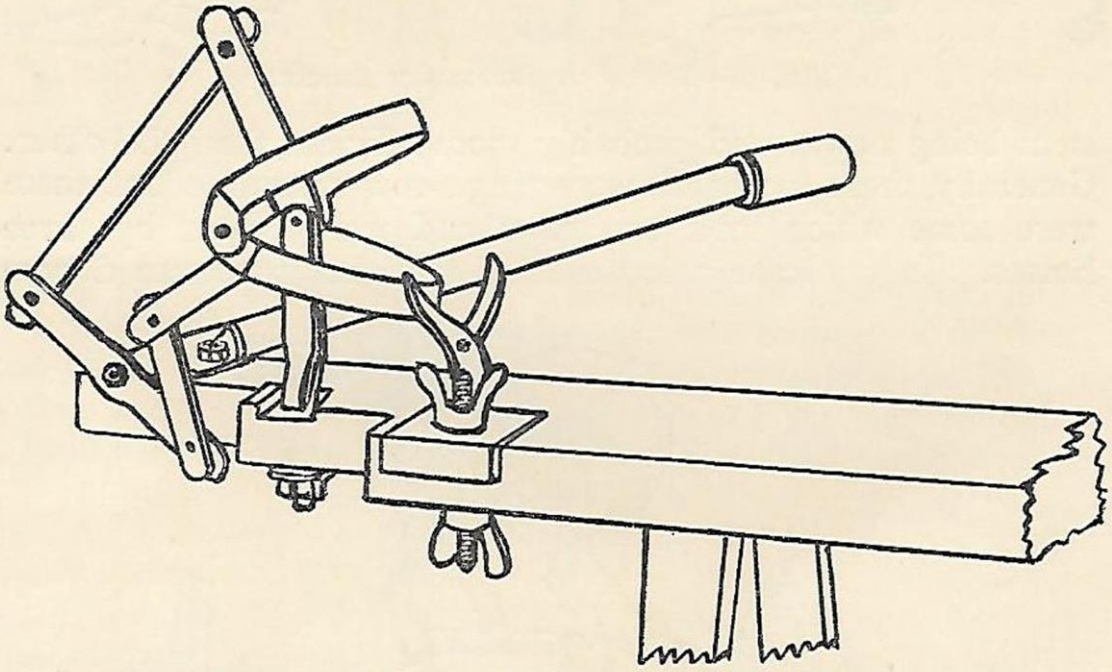


FIG. 8.—TOPPING DEVICE USED IN U.S.S.R.

these lines but none of them was seen in actual operation. Fig. 8 shows one hand-operated device for the purpose. Another device (of which only photographs were seen) was mounted on a transportable frame that could be hauled from place to place by a tractor. It consisted of a set of rotating cutters arranged so as to give a conical shape to the crown of a beet when the latter was pressed against them. These cutters were mounted at the centre of a flat disc cutter and the whole was driven from the power take-off of a tractor. Two such units were mounted on one frame with seats alongside for their operators. In operation a beet was first presented to the disc cutter so that the leaves were removed immediately above the crown and the latter was then pressed against the conical cutters so that it was pared to the required shape. The

Soviet system of topping has obviously no application in this country and is described only as a matter of general interest.

Beet looseners were generally of the single-share subsoiler type. Three typical forms are shown in Fig. 9. The first two of these are most commonly seen, the type with the curved

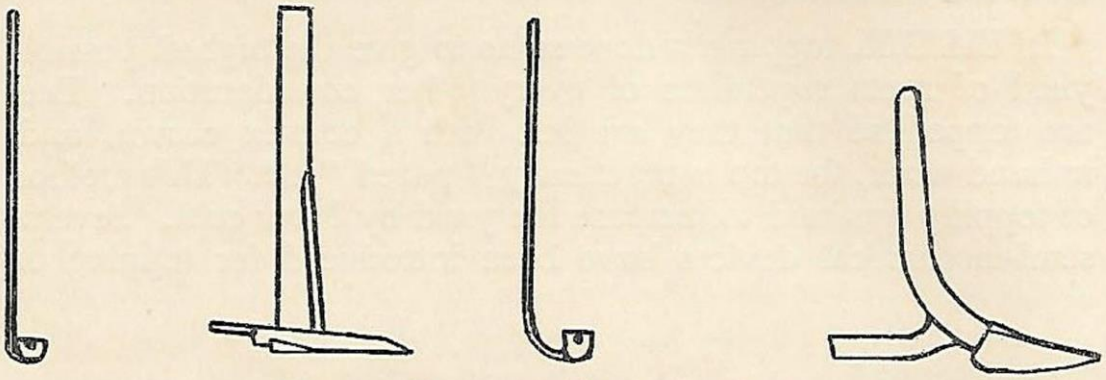


FIG. 9.—TYPES OF LOOSENER SHARE.

stem being newer and probably more efficient than the other. Generally these looseners were single-row machines but there were some which took two rows and were drawn by three horses. In one case a loosener of the straight-stemmed type

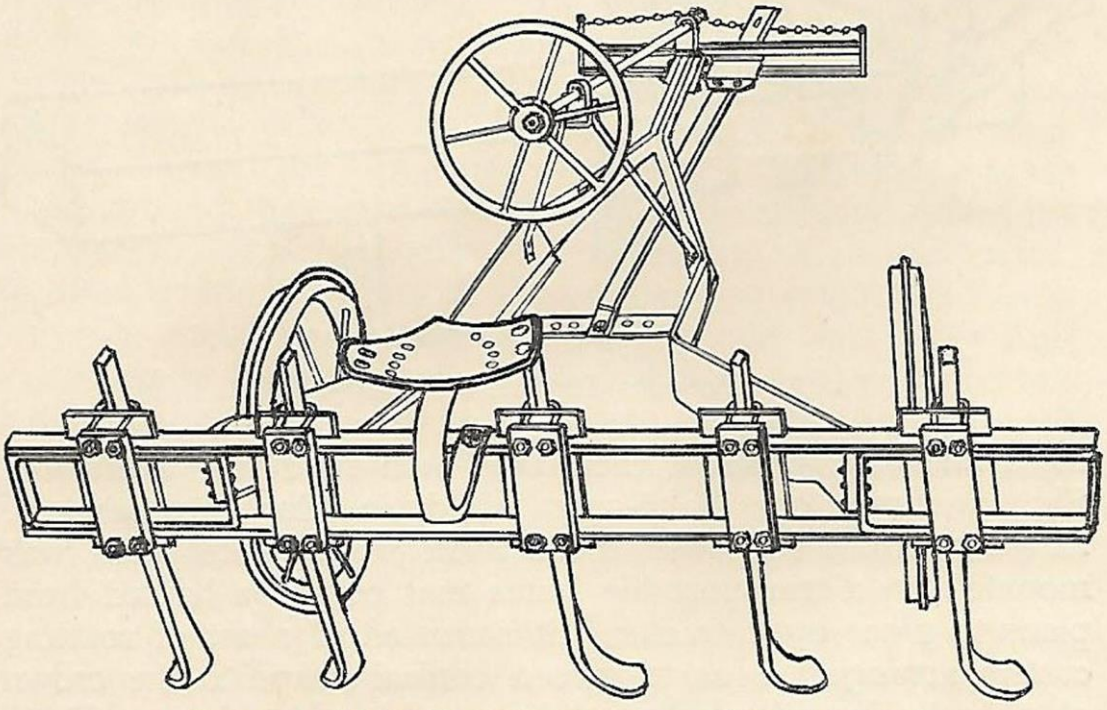


FIG. 10.—U.S.S.R. 5-ROW TRACTOR "LOOSENER."

was coupled in an off-set position behind a tractor which also pulled a narrow Cambridge roll for levelling the ground disturbed in lifting the previous row. Fig. 10 shows a 5-row tractor loosener seen at work in the U.S.S.R. where 4- and 6-row machines of similar design were also used. It will be seen that in this instance all the work is done by a curved stem,

no cartridge or share being fitted. This machine was doing excellent work. It was difficult, except by close examination, to detect the rows it had passed over, but the beet were thoroughly loosened and could easily be pulled out.

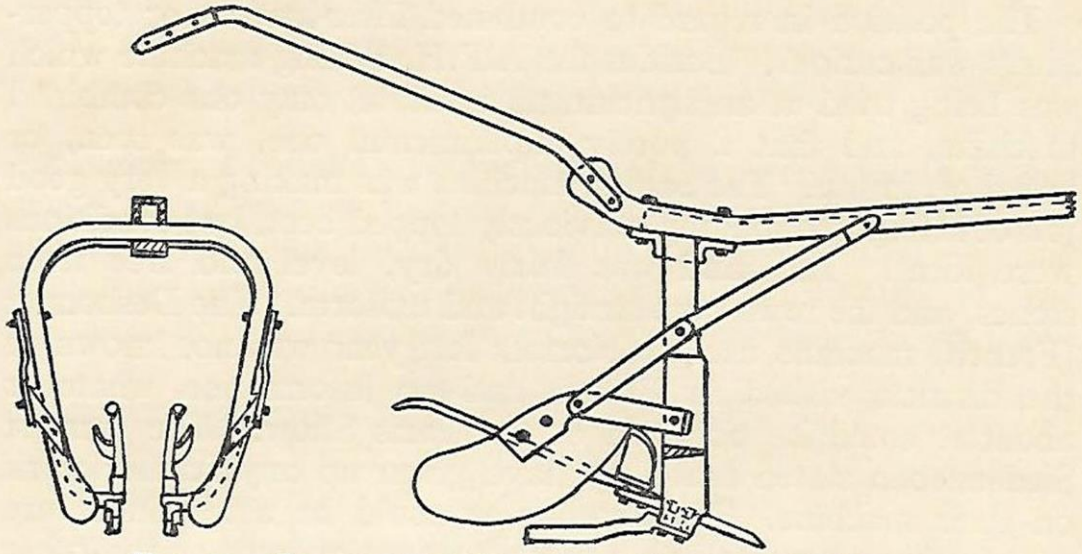


FIG. 11.—LIFTER FOR USE WITH "POMMRITZ" METHOD.

Loosener-lifters of the double share and forked types, more common in this country, were also seen in a number of districts, but under the prevailing conditions appeared to have no special advantages to offset the disadvantages of heavier draught, liability to choking by stones or bolters, and necessity for

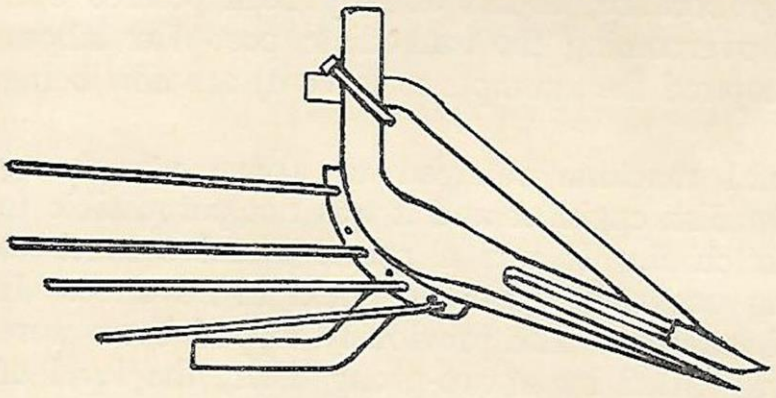


FIG. 12.—LIFTER SHARE FOR USE WITH PREVIOUSLY TOPPED BEET.

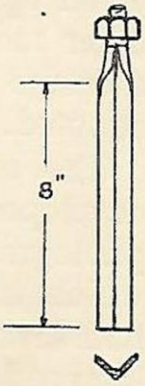


FIG. 13.—TINE OF SWEDISH SEED-BED HARROW.

frequent renewals of shares. The most interesting machines of these types were those designed for use on previously topped beet. Two of these are shown in Figs. 11 and 12. Fig. 11 shows the type originally designed for use with the Pommritz method of topping in the ground by machine, while Fig. 12 shows a plough attachment made by Rud. Sack. The latter was observed in action under by no means ideal conditions in Central Germany and was doing excellent work. The beet

were neatly laid on one side and fairly well separated from the soil (which was rather dry). They were afterwards knocked together and thrown into heaps, four women being required to keep up with the machine.

The position in regard to combined lifter-loaders or topper-lifters was curious. Besides the A.P.H. Salling machine which was being tried at an agricultural institute, only one combined machine, and that a purely experimental one, was seen, or heard of, in use. The Salling machine was making a very good job of lifting and loading previously topped beet, but conditions were ideal. The land was fairly dry, level and free from stones, and the rows were straight and uniform. The Desbonnet (French) machine used in Norfolk last year was not known in the districts visited in France and no information whatever about it could be obtained at the Paris Show. The firm of Siedersleben stated that they have given up any further work on their machine. Nor, so far as could be ascertained, are any further attempts being made to develop any of the other Continental machines (such as the Marlière, the Walter and Kuffer, and the Belgian machines) which have been seen on occasion in this country. Even in U.S.S.R. it was stated that attempts to design a reasonably efficient combined lifter had so far failed. Over the greater part of the Continent, in fact, the problem of the combined lifter appears to have been entirely given up, probably because, as has already been pointed out, other methods of overcoming the immediate post-War labour shortage (which inspired the attempts to solve it) are now being adopted.

The experimental machine referred to above was being developed by a Swedish engineer and it was not permissible to photograph or sketch it. It was a rather massive machine which while lifting one row topped the next in advance. It had several novel features. The previously topped beets were loosened and partly lifted by a two-prong lifter, the level of which was controlled by a kind of sledge which ran over the top of the beet. The beets were removed by an elevator, the slats of which carried prongs which penetrated the loosened soil and scooped out the roots. The elevator delivered the beet to a large horizontal rotary cleaner from which they were ejected into a large hopper for periodical dumping. Topping was done by a rotating knife also controlled by a sledge, and the leaves and crowns were taken by a binder-type elevator of wire-mesh construction to a second hopper. An unusual feature was a flexibly driven auxiliary topper which could, in theory, be used to pare a little more off any insufficiently

topped roots. In practice it would be almost impossible to keep pace with the machine unless the roots which required attention were few and far between. At the time of the visit this machine was at a standstill on account of a minor mechanical breakdown, but the work it had been doing was inspected. Technically, the machine was very promising, but seemed likely to prove much too expensive for the ordinary grower.

Cleaning, Loading and Transport.—The majority of Continental sugar-beet is cleaned, as in this country, only by knocking the roots together at lifting time. Cleaning on the ground by harrowing was mentioned in several districts but was not actually seen in progress. The harrows used are generally

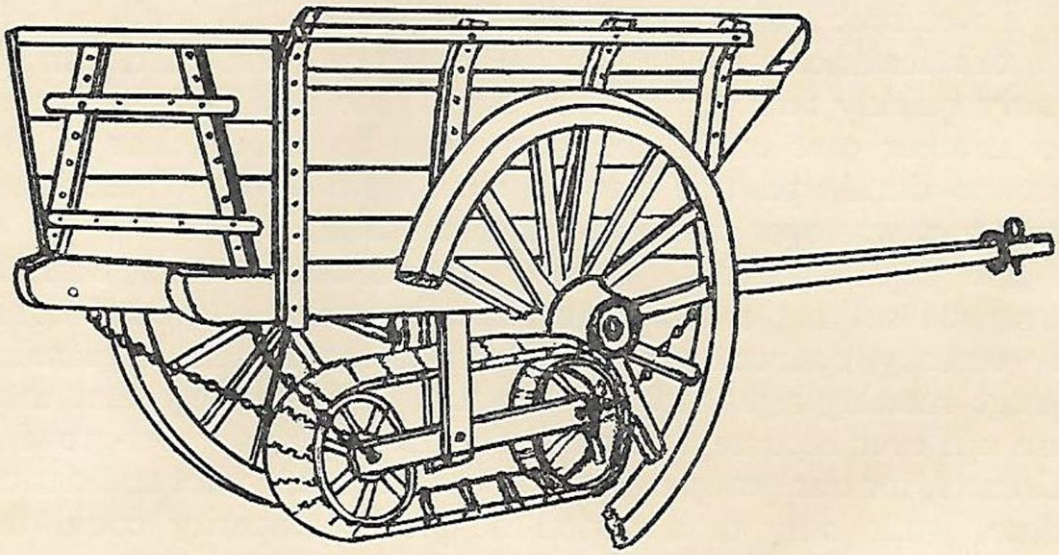


FIG. 14.—TRACKLAYING ATTACHMENT FOR CART.

of the blunt-tined tripod type already mentioned as being used in seed-bed preparation. In one instance, they were attached to and followed by a wooden harrow with very few tines which " combed " the roots out of the loose litter in which the tripod harrow left them embedded. In another case the tripod harrow was suspended on the underside of a sledge carried on two high runners. These runners were fitted along the sides of the sledge and were splayed outwards at the forward end and bent inwards at the rear. The height at which the harrow was suspended above the ground was adjustable, so that the severity of the harrowing could be varied to suit prevailing conditions. The arrangement of the runners was intended to collect the beets after cleaning into neat narrow rows for easy loading.

Apart from the use of light railways, which is a notable feature in most European countries, Continental growers can hardly be said to have progressed far in the matter of beet

transport. No mechanical cleaning or loading devices of any kind were seen either in the field or on exhibition, although the very high-sided wagons commonly used must have made loading and unloading a very arduous task. Again, pneumatic tyres were not very evident, and, in the few examples seen, were used less efficiently than in this country. They were generally fitted to existing wagons without any attempt to gain the benefits of a larger low-loading body which they offer. Sledges were sometimes used when conditions were very wet.

At some of the agricultural shows visited there were exhibits of tracklaying trailers and of tracklaying attachments for farm carts, designed to facilitate farm haulage under wet or rough conditions. A typical example, which would be very useful in a wet beet harvest, is shown in Fig. 14. The unit, which, in this instance, is fitted to an ordinary farm cart, can be fairly quickly removed at the edge of the field for attachment to another cart or, if necessary, can be raised clear of the ground during passage along a road. No device of the kind, however, was ever seen at work in the field.

The light railways, already mentioned, were generally arranged so that a temporary line from the field itself could be directly connected with a permanent system of similar gauge running right into the factory. It is unlikely that their use will ever become a common feature of British beet-growing districts, for our grouping around the factories is not sufficiently close, while only in a period of great prosperity could the necessary capital be expended for laying out the permanent system on which the efficiency of the whole depends.

UTILIZATION OF BEET TOPS

Beet tops on the Continent are nearly always used for stock feeding. They are ploughed in for manure only on the relatively few farms that are worked without livestock. Fattening cattle are not plentiful and it is impossible in most cases to feed sheep on the land during winter. Beet tops, therefore, are carted off the land and used mainly for feeding dairy cattle. In the early part of the season the tops are sprinkled with feeding chalk and fed green to the cows in the sheds, being strewn along a passage-way between two rows of cows standing face to face. As soon as the cows have eaten as many tops as they will clear up readily, the remainder is immediately removed from the sheds. By taking this precaution and by feeding tops before the leaves have decayed it is claimed that milk taint is avoided.

Carting off of the tops kept pace with lifting and the fields were frequently cleared of beet and tops almost at the same time. It is not usual to wilt the leaves for any length of time before using them and they were, therefore, generally fed in fresher condition than in England. Possibly tops must necessarily be removed promptly on account of danger from frost, nevertheless great care was taken over their removal and use before the leaves began to rot. Tops not required for immediate feeding were ensiled, either in pits lined with brick or concrete (sometimes covered to keep out rain), or in heaps above ground level. A very common practice was to ensile alternate layers of beet tops and wet pulp. When heaps were used they were well consolidated by driving bullock teams over the top of them. They often covered a very large area and might be up to 10 to 12 ft. high. Light railways were sometimes assembled over them to facilitate building. The heaps were covered with soil after they had settled.

Farming in the beet districts depends very largely on beet-top residues for stock feeding, and silage may be fed to dairy and other cattle as late as the month of June or longer if the supply holds out. There was no difficulty in keeping well made beet-top silage, and it appeared to be safe to rely on it to provide succulent food for the cattle from October to the end of July.

SUMMARY

In the countries visited during the tours described in this report, sugar-beet growing is concentrated in certain well-defined areas, to which the greater part of the time available was therefore devoted. Within these areas the beet-growing farms are closely grouped around the factories, generally within a radius of 15 miles, and beet is the pivotal crop of their rotation around which the whole farming system, and the livestock husbandry in particular is planned. Practically all the beet is grown on deep, free-working soils either naturally rich or in very good heart, and the poorer sandy soils are avoided.

Over the whole Continent, agriculture is of more importance than it is in Great Britain, in the sense that it engages a greater proportion of the total population, and sugar-beet cultivation has been carried on for generations past. There is thus a more plentiful supply of skilled labour in Continental beet districts than there is at home and in consequence little attention has been paid to the use of mechanical power. In this respect the methods of some British growers are more progressive than

anything that was seen in general use abroad, with the possible exception of the U.S.S.R.

Many of the details of cultivation described in the report are influenced by the widely-varying climatic conditions of the particular countries concerned. In particular, although they are not without interest, the methods practised in the drier districts of Central Europe, with their early corn harvest and short beet-growing season, are less significant to British growers than those practised in Scandinavia, Holland, Belgium and N. France, where conditions more closely resemble our own. Over the Continent as a whole the two main features of the preliminary cultivations were first that ploughing was done as soon as possible after the corn harvest, and secondly that, by one means or another, the land was broken to a depth of at least a foot. In most cases the land was ploughed to at least this depth; but in some districts, where the effects of bringing unweathered soil to the surface were feared, shallower ploughs fitted with subsoiling tines were used. One-way ploughs were extensively used in some of the Atlantic countries and appeared to have definite advantages. A more common use of these ploughs in this country is to be recommended and would be assisted by the development of a deep-working one-way tractor plough of British manufacture.

Subsequent cultivations aimed always at providing a fine, firm seed-bed, which would give quick and even germination. The exact method of preparation varied considerably but the result was generally a finer and firmer surface than is common at drilling time in this country. The better result appeared to be due partly to the fact that more work is put into Continental seed-beds and partly to the use of a wider range of implements intermediate in action between roll and harrow. Among these, the float, which is not unlike the scrubber formerly used in the north of England and the Midlands, and the rolling harrow, appeared to be especially useful implements worth trying out thoroughly in this country. Other noteworthy features of seed-bed preparation were the use of shallow surface-working implements in the early stages and the tendency to complete the preparation and drilling of a given piece on one day.

Continental drills were generally 2-horse drills, taking from 6 to 10 rows, and fitted with forecarriage steering. Four-row drills were more often used in the Atlantic countries and on the small farms. Some points of detail in their design were of interest, notably the provision of means for easy calibration and of a wide range of covering and rolling attachments for

individual coulters. In general, however, these wide forecarriage drills are not well suited to the smaller fields of most British growers, and a more generally useful implement for our own use would be a drill just wide enough to require the full effort of one horse and provided possibly with coulters steered from the rear by means of a lever. The Continental practice of fitting a light float or harrow immediately in front of the coulters in order to take out the horses' hoof-marks is worth noting. This device was generally attached to the forecarriage but an alternative means of attachment suitable for British drills could easily be devised.

Continental growers in general aim at higher plant populations than are common in this country. In the drier districts populations range from 40,000 to 60,000 plants to the acre, while even in the wet districts, where conditions of climate and labour are more comparable with our own, populations of from 32,000 to 36,000 are generally aimed at. Rough counts in the field suggested also that on the whole Continental growers are more successful than we are in obtaining a high percentage of the theoretical full plant. Among possible reasons for this may be mentioned the use of seed rates higher than 20 lb. per acre, the general use of narrow rows, averaging about 16 in., and the availability of a plentiful supply of skilled labour for singling. Many different methods of singling were employed, perhaps the most common being singling by finger and thumb after previous bunching. Great care was taken in the dry countries to avoid the plants falling over during singling. This precaution was not considered to be so essential in the wet countries.

Mechanical methods of plant spacing were not much in evidence although instances of cross-blocking were seen in Belgium and Germany, and spaced drilling was quite extensively practised in S. Sweden. Cross-blocking in both countries was done generally in the manner with which we are familiar in this country but the method was used only when there was a risk of a plant growing away before singling. Spaced drilling was being used by a number of Swedish growers mainly as a means of getting a more uniformly spaced plant with the additional advantage of a considerable saving of seed. A drill of Czechoslovakian manufacture was used, and, since plant counts at harvest time showed a population of nearly 34,000 plants per acre, the machine should be worth trying in this country.

Continental horse-hoes were generally as wide as the drills and of the forecarriage type. Independent self-regulating hoe

brackets were almost universal, and in all the wide models the frames were counterbalanced for easy lifting. From the point of view of British growers forecarriage steering appears to be an unnecessary complication; while except in soil of very uniform texture the difficulty of securing even penetration with independently mounted hoes would appear to outweigh their advantages. For our conditions a hoe as wide as can be pulled by one horse, fitted with rigid stemmed hoes on a sliding-axle steerage, and provided with a counterbalanced lift, would probably be as satisfactory as any more complicated type.

The design of Continental hoe blades does not differ in any essential feature from those in common use at home, but the number of times the crop is horse-hoed is much greater in the dry than in the wet countries, where, as in England, the horse-hoe is used 5 or 6 times during the growing period.

The practice in regard to manuring in the different countries varies widely with local conditions. On the whole, manuring is more lavish than in Britain. The fact that beet requires heavy nitrogenous manuring is generally recognized, and in most places the dung cart is still an important factor. Combined seed and fertilizer drills are not extensively used, probably because certain manures are known to hinder plant development when sown with the seed.

Lifting on the Continent is done mainly by methods familiar at home, i.e., by hand with short spuds or forks or with the aid of a lifter of the loosener type. Combined lifter-loaders or topper-lifters are not used commercially nor is their experimental development being seriously considered. British growers have, of course, based their lifting practices on Continental methods and it is not to be expected that the methods adopted in the hand work would differ very much at this comparatively early stage in the development of the British beet crop. There is, however, no agreement on the Continent on such simple matters as the necessity to use a lifter, but the impression obtained suggested that the beet lifter or loosener was really not required, except, perhaps, on the heavier soils. Beet transport in many districts centres around the use of light railways connecting the field directly with the factory. Apart from this feature, however, Continental growers are not progressive in the matter of transport. Mechanical loading or cleaning devices are virtually unknown and little use is made of pneumatic tyres.

Beet tops on the Continent are nearly always used for stock-feeding and are generally regarded as being too valuable to be ploughed in. They are carted off as early as possible, sometimes

as soon as the beet itself, and those that are not fed immediately are ensiled in heaps or pits together with fresh pulp. Stock farming in the beet districts depends very largely on these residues and well-made top and wet-pulp silage is relied on to provide succulent cattle food from October until the end of July if necessary.

The intimate co-operation between the factories and the growers is noteworthy. Sometimes the association of the two imposes conditions upon the growers that would be undesirable at home, but, in general, there are organized attempts at improvement of the crops, which is recognized as equally to the advantage of the factory. Closely linked to this work by financial and other assistance are the Sugar-beet Research Stations and Sugar Institutes found in almost every country, and types of sugar-beet specially suited to each country have been developed, nearly always as the result of private enterprise.

Beet growing does not appear to be very profitable on the Continent. Beet prices are generally lower than those at home, but compensating factors such as free beet pulp, the maintenance by the factory of light railways, cheaper labour, to mention only one or two of these factors, introduce complications that make exact comparison impossible. Nevertheless, all Continental growers endeavour, sometimes successfully, to make a cash profit on the sale of the roots and thus have the use of the beet tops as an additional asset.

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Pests and Diseases of the Sugar-Beet

BY F. R. PETHERBRIDGE, M.A. AND
H. H. STIRRUP, M.Sc.

MINISTRY OF AGRICULTURE AND
FISHERIES BULLETIN 93

The sugar-beet crop, which is steadily growing in favour in this country, has hitherto remained relatively free from pests and diseases. There are, however, indications that this comparative immunity may not continue. The prompt detection and control of pests and diseases that may appear are therefore of paramount importance.

The purpose of this Bulletin is to bring before all interested in the growing of the crop the data obtained by the authors during their visit in the summer of 1934 to the chief Continental areas in which beet is grown. It is believed that the information so secured will be of service to all connected with the industry.

Mr. Petherbridge, who is responsible for the entomological section, deals with the continental insect pests, including those foreign to as well as those common to this country. These comprise the beet eelworm and the various species of plant bugs, moths, beetles, flies and millipedes. The mycological section by Mr. Stirrup contains extensive information on Blackleg, Strang e Disease, Heart Rot and Dry Rot, Virus Diseases and non-virus types of Yellows, while other diseases dealt with include Mildew, Leaf Spots, Rusts, Root Rot, Scab, Crown Gall, Root Tumour and that caused by *Typhula Betae*.

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